ACADEMY OF SCIENCES OF MOLDOVA
BOTANICAL GARDEN (INSTUTUTE)

JOURNAL OF BOTANY

VOL. VI **NR. 1(8)**

Chisinau, 2014

FOUNDER OF THE "JOURNAL OF BOTANY": BOTANICAL GARDEN (INSTITUTE) OF THE ASM

According to the decision of Supreme Council for Sciences and Technological Development of ASM and National Council for Accreditation and Attestation, nr. 288 of 28.11.2013 on the approval of the assessment and Classification of scientific journals, "Journal of Botany" was granted the status of scientific publication of "B" Category.

Edition supported by the Supreme Council for Sciences and Technological Development of ASM

Botanical Garden (Institute)
MD – 2002, Padurii str. 18, Chisinau, Republic of Moldova
tel./fax.: (+373 22) 52-35-89; 55-04-43
www. gradinabotanica.asm.md
e-mail: cancelarie.gb@asm.md

CONTENTS

I. Structural and functional diversity of plant organisms

II. Conservation of biological diversity

III. Introduction of plants and sustainable use of plant resources.

IV. Landscape architecture

V. Scientific chronic

Allocution
of the Academician GHEORGHE DUCA
President of the Academy of Sciences of Moldova
at the International Scientific Symposium
"Conservation of Plant Diversity"
22-24.05.2014, Chişinău
Honourable audience!

Biodiversity Conservation, Climate Change and Poverty Reduction were recognized, in 1992 at the United Nations Conference on Environment and Development in Rio de Janeiro, as pillars of the Sustainable Development of the human society. At the same time, these areas were identified as priority concerns of the global scientific community. The Republic of Moldova, ratifying that Convention (on Biological Diversity, Climate Change), has committed itself at international level to stop biodiversity degradation and has taken adequate measures of development of the regulatory and institutional framework, intensification of the scientific research in this field. Environmental protection is a priority for the socio-economic development of the Republic of Moldova and is reflected in the policies of the country regarding the accession to the European Union.

The adoption in 2004 of the Code on Science and Innovation of the RM and then of the strategies for Research and Development of the Scientific Research Institutions influenced the studies meant to promote scientific research by making ambitious programs and projects in order to achieve new knowledge on biological diversity, and to use this knowledge to solve socio-economic problems of the country. Application of the principle of contest and attracting young people in the research and innovation process, improvement of the quality of scientific research by using advanced equipment and modern methods, intensification of the collaboration at national level and with the international scientific centres represent the best achievements in the recent years. These tools and mechanisms of increasing the research efficiency are at a new stage of completing according to the new requirements and circumstances, by promoting changes in the respective Code, elaboration of a new strategy for Research and Development in the Republic of Moldova.

It is gratifying the fact that the organization of the Symposium is carried out with the active participation of the Educational-Scientific Cluster "UniverScience". The common activities of the research institutions and the University of ASM bring their beneficial contribution to the efficient training of young people, future researchers in various fields, who, we hope, will contribute in the future to the development of the Republic of Moldova.

The free exchange of information by using the "Clearing-House Mechanism" and the collaboration at national and international level is a primary requirement in the efficient integration and cooperation in the process of conservation of biodiversity. The International Scientific Symposium "Conservation of Plant Diversity", which today is at its third edition, is also dedicated to this goal.

In this context, the tasks of the research institutes of the ASM, the goals of the Ministry of Environment, Moldsilva Agency etc. develop and diversify, with the tendency to contribute the most efficiently to the salvation of the planet's natural heritage.

The Academy of Sciences, including the Botanical Garden, the respective chairs of our universities contribute to the enrichment of the knowledge on the plant world, to the development of theoretical bases regarding the conservation and sustainable use of biodiversity, ecological restoration of degraded habitats, protection of rare species, database creation and implementation of a management system based on the promotion of conservation concepts.

Through the collaboration with the Academy of Sciences of Moldova, Ministry of Environment, Moldsilva Agency, UNDP, World Bank, the Fund of Natural Areas Protected by the State has grown from 1.96% to 5.6% of the national territory. A new set of laws and regulations that have contributed to the fulfilment of the national and international tasks on biodiversity conservation have been developed and approved; the Orhei National Park has been founded; projects on the creation of the Biosphere Reserve "Lower Prut" have been initiated.

On the basis of joint research, monitoring and evaluation activities from the recent years, scientific articles, monographs, textbooks and methodical-didactic works, which are now exhibited in the hall of the Central Library, have been published and you can appreciate them.

It has also been developed and adopted by the Parliament of the RM, the Biodiversity Conservation National Strategy and Action Plan; it is going to be published the third edition of the "Red Book" and the fundamental work in six volumes "The Flora of Bessarabia".

We can surely say that the researches in the Republic of Moldova have contributed to solving several regional problems on biodiversity conservation, rational use of flora and vegetation, introduction of new alien species, developing recommendations on

ecosystem management regime, maintaining the ecological level in optimal regime of activity in agriculture and forestry, landscape planning in the country, environmental education.

In collaboration with the Agency for Innovation and Technology Transfer, a number of scientific developments were implemented in the national economy. I am sure that many of you, through hard work, have contributed to the realization of the national and regional programmes. I would like just to mention that in the last five years, the Botanical Garden has promoted 35 new plant species to be used in the national economy.

Due to the cumulative efforts of the scientific community, it became possible the association with European programs such as the EU Framework Programme 7 and the recently launched the programme "Horizon 2020", which is a support in obtaining infrastructure upgrading projects, mobility for young people, purchase of scientific equipment, collaboration with research institutions from abroad.

The strategic objectives for the future, of the scientific community in the domain, aim at enriching knowledge, forming a responsible attitude towards the protection of biodiversity, developing scientific bases of conservation of the plant world, including the systematic research on the flora and plant resources of Moldova, the development of the system of Natural Areas Protected by the State, the mobilization and the introduction of various species of trees and shrubs, flowering, fodder, technical, aromatic, medicinal plants and the promotion of the promising ones for the national economy.

We are sure that the way begun by our predecessors and continued today by you, materialized due to numerous personal and collective efforts and sacrifices by enthusiastic people, devoted to the scientific ideas.

Recalling the beginnings, we pay a tribute to those who have contributed to the development of this scientific field, so necessary in our society.

We still have many problems to solve, but I am sure that through common efforts we will succeed. Our duty is to act promptly and knowledgeably, to protect the Nature which helps us to survive, but which can severely punish us if we treat it irresponsibly.

On the occasion of this important international symposium, I wish the participants success, health, happiness and prosperity, to have patience, courage to overcome hardships, new successes in your noble work, the results of which are particularly valuable for various branches of science and economy of our country.

I. STRUCTURAL AND FUNCTIONAL DIVERSITY OF PLANT ORGANISMS

THE INFLUENCE OF TEMPERATURE ON SEED GERMINATION IN SOME SPECIES OF MEDICINAL AND AROMATIC PLANTS

Adina Cătălina Druţu, Lorena Diana Popa, Alexandra Andreea Buburuz Simona-Florina Pochiscanu, Traian Ioan Pomohaci

Agricultural Research – Development Station Secuieni, România

Abstract: Given the fact that many of the seeds of medicinal and aromatic plants spring up very slowly and unevenly, at A.R.D.S. Secuieni were experienced in laboratory conditions, speeding up and improving germination in the species *Hypericum perforatum* L., *Echinacea purpurea* L. (Moench.) and *Salvia officinalis* L. Due to the research made at A.R.D.S. Secuieni was found that the optimum temperature for germination in the laboratory conditions to the seeds of the three species is 20 – 22^{0}C. The organic treatments made at seed led to shortening the period from when the seeds were put to germinate and until they began to germinate, but also of the period from sowing to emergence. The most effective variant was the one where the seeds were soaked 48 hours and were kept in refrigerator for 12 hours at 40ºC, the period from sowing to emergence at the *Hypericum perforatum* L. was reduced to 9 days versus 48 days (in control variant - untreated). At *Echinacea purpurea* (L) Moench. still to this variant the period from sowing to emergence was reduced to 8 days compared to 45 days as it was in the control variant – untreated, and at *Salvia officinalis* L. this period was of 6 days.

Key words: temperature, seed, medicinal and aromatic plants.

INTRODUCTION

Hypericum perforatum L. (St John's wort, Goat weed, Saint John grass), *Echinacea purpurea* L. (Moench.) and *Salvia officinalis* L. (sage) are valuable species grown and used in therapy for herba (St John's wort and echinacea) and leaves (officinalis) (*Siritanu Carmen and all, 2006*). Even if at these species was established the way and the optimal seeding period for Moldovian Center conditions (2) the establishment of a culture is hard enough, as the seeds from these species are quite small, springing hard and uneven and the period from sowing to emergence is very long (40-50 days) (Muntean, L.S. si colab, 2007). When at this time the amount of water from rainfall is low the number of days from sowing to emergence can reach 60 (*Verzea Maria and all, 2001*).

At A.D.R.S. Secuieni were tested in laboratory conditions, speeding up and improving germination at *Hypericum perforatum* L., *Echinacea purpurea* L. (Moench.) and *Salvia officinalis* L. species. Experiments completed in this sense aimed at determining the optimum temperature for germination and identifying some organic seed treatments in order to boost germination capacity.

MATERIALS AND METHODS

The experiments were carried out at A.R.D.S. Secuieni, in the Laboratory of Medicinal and aromatic plants. The temperature steps used at the seed of the three species (St. John's Wort, sage and echinacea) were 10^0C, 15^0C, 20^0C and 22^0C. Regarding the organic treatment in order to reduce the germination time, they consisted in moistening and applying thermal shock to the seed, namely:

- 24 hours moistened seeds;
- 48 hours moistened seed;
- 24 hours moistened seed + 24 hours kept in the refrigerator at 4^0C;
- 48 hours moistened seeds + 12 hours kept in the refrigerator.

After performing the non polluting seed treatment, they were washed with water, operation which aimed the removal of any substance that may inhibit the germination process. Then, half of the seeds were put for germination, in Pétri dishes, using filter paper as the substrate germination, and the rest were sown. In field, the experiments were monofactorial and were placed on a typical cambic chernozem soil after randomized block method in four replications version area being of 8 sqm. The seeds used in the experiments were from the experimental field of medicinal and aromatic plants laboratory of A.R.D.S. Secuieni from 2012 harvest. In all species, the sowing was done by hand, at a distance of 50 cm between rows and 15 cm between plants, at a depth of 1.5 cm.

RESULTS AND DISCUSSIONS

At *Hypericum perforatum* L. seeds the optimum temperature for germination in laboratory conditions was of 22^0C. At this temperature the seeds have begun to germinate after 5 days from the start of the experiment, the trial lasted 15 days and at the last measurement 85% of the seeds had germinated (Figure 1). As a result of the treatments made at rattles seeds, the shorter germination period (13 days) and the lowest length since the seeds were put to germinate and until they began to germinate (4 days) was achieved in 48 hours moistened variant + 12 hours in the refrigerator. In this variant the seeds have germinated in a proportion of 97% (Figure 2). Also in this variant, the period from sowing to germination was short, of 9 days. At the untreated (control) variant this period was of 48 days and at the 48 hours moistened variant the number of days from sowing to emergence was of 13 days. (Figure 5). In terms of establishing

the germination optimum temperature of *Echinacea purpurea* (L.) Moench. seeds under laboratory conditions, from the 4 temperature stages investigated, has proved to be the optimum temperature of 22^0C (Figure 1). At this temperature the seeds have begun to germinate after 3 days from the start of the experiment, the trial lasted 11 days. At the last measurement 89 % of the seeds had germinated. At a temperature of 20^0C the seeds started to germinate at 5 days from the start of the experiment and the percentage of germinated seeds was 87 % and occurred at 13 days. As a result of organic treatments performed at *Echinacea* seeds, the germination shortest period (10 days) and lowest duration in days since the seeds were put to germinate and until they began to germinate (2 days) was recorded in the 48 hours moistened variant and kept in a refrigerator (4^0C) for 12 hours. In this variant the seeds had germinated in a proportion of 97 % (Figure 3). Regarding the period from sowing to emergence, this was shorter than 8 days to the same variant. In the untreated variant this period was of 45 days, and at the 48 hours moistened variant and 24 hours refrigerated the period from sowing to emergence was of 12 days (Figure 5). At *Salvia officinalis* L. seeds, the optimum temperature for germination in laboratory conditions was of 20^0C and 22^0C, temperatures at which the seeds began to germinate after 3 days since were put to germinate and the final germination was of 98% (Figure 1). As a result of the treatments made at sage seeds, the shorter germination period (10 days) and lowest duration since the seeds were put to germinate and until they began to germinate (3 days) was achieved in 48 hours moistened variant + 12 hours in a refrigerator. In this variant the seeds have germinated in a proportion of 95% (Figure 4).

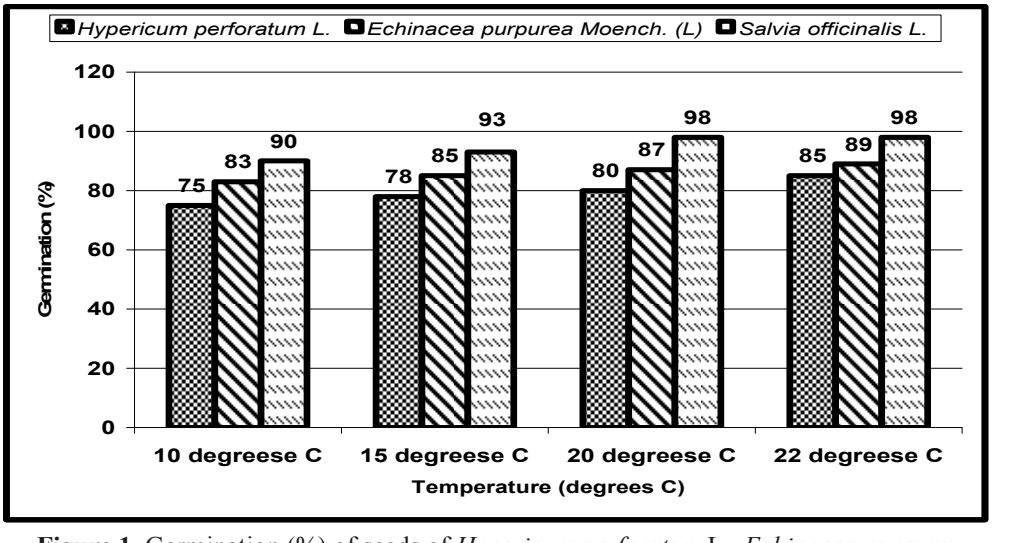


Figure 1. Germination (%) of seeds of *Hypericum perforatum* L., *Echinacea purpurea* Moench. (L.) and *Salvia officinalis* L. at different levels of temperature

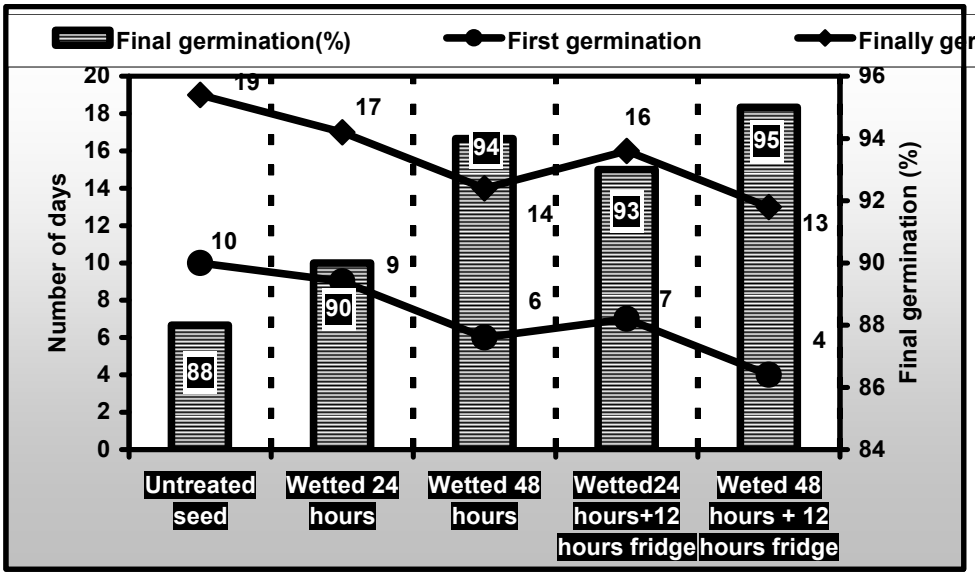


Figure 2. Influence of organic seed treatments of *Hypericum perforatum* L. in germination

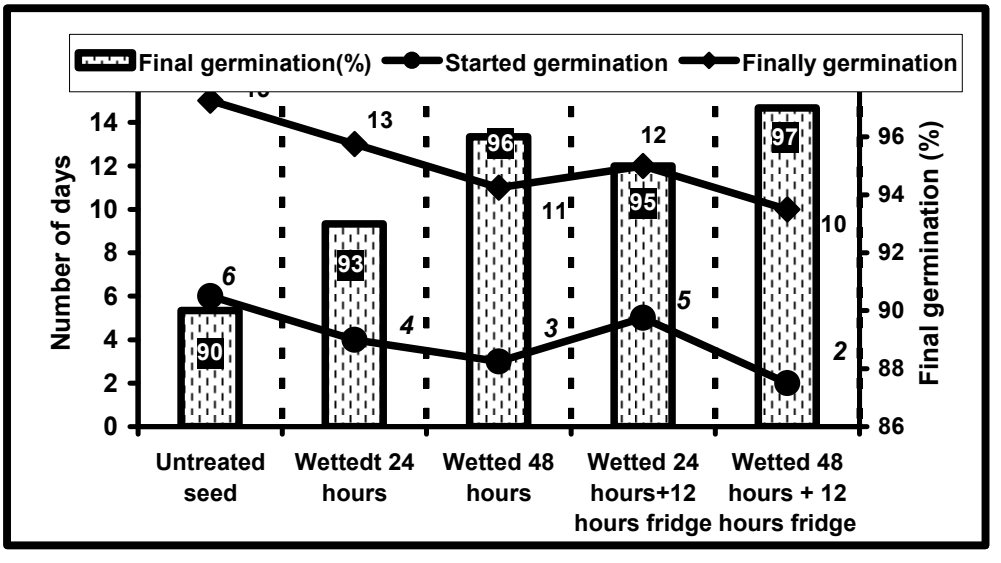


Figure 3. Influence of organic seed treatments of *Echinacea purpurea* (L) Moench. in germination

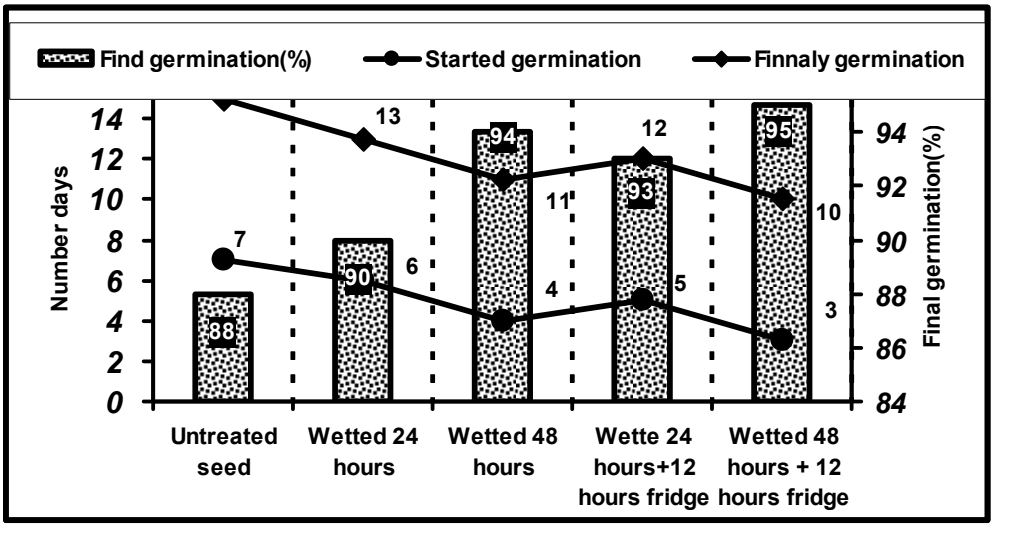


Figure 4. Influence of organic seed treatments of *Salvia officinalis* L. in germination

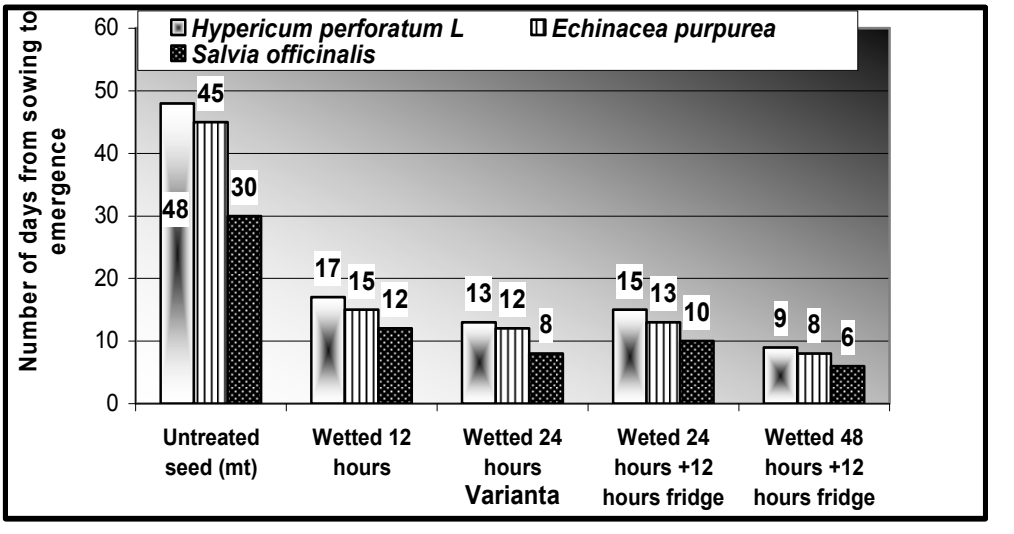


Figure 5. Influence of seed treatments in *Hypericum perforatum* L., *Echinacea purpurea* Moench. (L.) and *Salvia officinalis* L. on emergence in the first year of vegetation

CONCLUSIONS

1. As a result of the researches made in A.R.D.S. Secuieni was found that the optimum temperature for germination in laboratory conditions at *Hypericum perforatum* L., *Echinacea purpurea* (L) Moench. and *Salvia officinalis* L. seeds was of 20 - 22^{0}C.

2. The organic treatments performed at the seed of the three species have led to the shortening of the period since the seeds were put to germinate and until they start to germinate, but also of the period from sowing to emergence.

3. The most effective variant was the one in which the seeds were moistened 48 hours and were kept in the refrigerator for 12 hours at 4^{0}C, the period from sowing to emergence at *Hypericum perforatum* L. was reduced to 9 days compared to 48 days (in the untreated variant).

4. At *Echinacea purpurea* (L) Moench. also in the same variant the period from sowing to emergence was reduced to 8 days versus 45 days as it was in the untreated variant, and at *Salvia officinalis* L. this period was of 6 days.

BIBLIOGRAPHY

1. Muntean, L.S., M. Tamas, S. Muntean, L. Muntean, M.M. Duda, D.I. Varban, S. Florian, 2007 – *Treaty of cultivated and wild medicinal plants,* Cluj-Napoca, 2007, Ed. Risoprint.

2. Siritanu Carmen, 2006 - *Determination of some biological and technical particularity at species Hypericum perforatum L. (tutsan) in A.D.R.S. Secuieni conditions* – Proceeding of XXXXIX Scientific Conference AGRICULTURE between tradition and intensivisation – UAMV Iaşi, 2006 , Editura “Ion Ionescu de la Brad” Iasi.

3. Verzea Maria şi colab., 2001 – Tehnologii de cultură la plantele medicinale şi aromatice – Ed. Orizonturi, 2001, Bucuresti.

DETERMINATION OF DROUGHT RESISTANCE OF GRAPEVINE ON THE BASE OF MORPHOBIOLOGICAL CHARACTERS OF LEAF BLADE

Valentin Codreanu

Botanical Garden (Institute) of the Academy of Sciences of Moldova, 18, Pădurii str. Chişinău, MD-2002, Republic of Moldova

Abstract. As a result of the determination of the biometric values of 21 morphobiological characters of the leaf blade at different species and cultivars of grapevine, 5 adaptive characters which cause the drought resistance of grapevine (*Vitis* L.) were established. The most drought-resistant are those species, cultivars and hybrids of grapevine at which: the dry mass of the leaf blade is higher; the percentage of the volume of the fresh and dried leaf blade from the area of the fresh and dried leaf blade is higher; the degree of succulence and the degree of sclerophylly of the leaf blade are higher.On the base of these 5 characters of the leaf blade, the method for determining the drought resistance of grapevine has been developed. By this method, it is determined the relative drought resistance of 12 species of the genus *Vitis* L., 15 cultivars of the species *Vitis viniera* L., 3 cultivars - direct producer hybrids, 2 rootstock cultivars, and 7 distant hybrids *V.vinifera* L. x *Muscadinia rotundifolia* Michx.

Key words: drought, resistance, leaf.

INTRODUCTION

With the aim to establish the adaptive characters of drought resistance of grapevine that can be used in selection and introduction works within the genus *Vitis* L., the biometric values of 21 morphobiological characters of the leaf blade at different species and cultivars of grapevine have been determined (Codreanu; 2006; 2009; 2013; Codreanu and co-authors, 2008). As a result of these studies, 5 morphobiological characters of the leaf blade, which cause the drought resistance of the species and cultivars of grapevine (*Vitis* L.), have been revealed and the method for determining the relative drought resistance of grapevine on the base of morphobiological characters of the leaf blade has been developed.

MATERIALS AND METHODS

As material for the study served the mature leaves of the species and cultivars of grapevine which were collected on 22.07.2011 and 24.07.2012 in the ampelographic

collection of the Practical Scientific Institute of Horticulture and Food Technology, situated near Chişinău. The leaves of the distant hybrids of grapevine were gathered in the collection of the Botanical Garden (Institute).

RESULTS AND DISCUSSIONS

The adaptation of grapevine plants to different conditions of water supply is based on the variability of the quantitative characters of the leaf, primarily, because leaf is the most plastic organ of the plant, which is receptive to the changes of the physical factors of the environment.

The biometric values of the morphobiological characters of the leaf blade at the species and cultivars of grapevine studied are shown in tab. 1 and 2.

The most drought-resistant are those species, cultivars and hybrids of grapevine at which: the dry mass of the leaf blade is higher; the percentage of the volume of the fresh and dried leaf blade from the area of the fresh and dried leaf blade is higher; the degree of succulence and the degree of sclerophylly of the leaf blade are higher.

On the base of these 5 adaptive morphobiological characters of the leaf blade, the method for determining the relative drought resistance of grapevine (*Vitis* L.) has been developed.

The method comprises the following 7 stages.

Stage I. Gathering of the fresh leaves of grapevine and their weighing with the electronic scales

This stage includes the following consecutive actions.

1. In the ampelographic collection, from the 7^{th}-12^{th} nodes of a normally developed and healthy sprout of the grapevine plant, we cut with scissors 6 healthy leaves and put them in a polyethylene bag.
2. In the laboratory, we measure with the millimetre ruler the length of the longitudinal diameter of the blade of each leaf and write the data in the register.
3. We cut with scissors the petioles of the leaves of the species or cultivars of grapevines brought to the laboratory.
4. We fold 6 leaf blades of each species or cultivar of grapevine and put them in aluminium weighing bottles clean and dry. Then we cover each weighing bottle with a lid.
5. We weigh with the electronic scales each weighing bottle with fresh leaf blades and we write their mass in the register.

   Note *. The enumeration of the nodes of the sprout has been done from its base to the top.

Stage 2. Determination of the amount of water and dry matter in the leaf blade of grapevine

The stage is performed according to the method of N.N. Tretiakov (1990).

1. We introduce the weighing bottles with the fresh leaf blades of grapevine in the thermostat at the temperature of 100-105°C for 5 hours. Then, we remove them from the thermostat; we cool them and weigh them. In order to remove all the water from the leaf blades, we repeat this procedure 3-4 times until the mass of each weighing bottle with leaf blades becomes constant.
2. We determine the dry mass of the leaf blades and the amount of removed water.
3. We determine the water and dry matter content (in %) from the fresh mass of a (1) leaf blade.

Stage 3. Determination of the average area of the leaf blade of grapevine

When calculating the average area of the leaf blade at the species and cultivars of grapevine, programmed for the study, the ampelometric method was used (Петраш, 1986). In accordance with this method, we calculate the average surface (area) of the leaf blade of grapevine using the formula $S = \frac{\pi d^2}{4} \div K$. The formula $S = 0.785 d^2 \div K$ has also been used (Ramadan, Omran, 2005).

Conventional signs: π - 3.14; K - correction coefficient. At unlobed leaves K = 1.25; at three-lobed leaves K = 1.27; at the leaves with 5 lobes, but little sectional K = 1.30, at leaves with 5 lobes more sectional K = 1.35.

Stage 4. Determination of the volume of the fresh mass of the leaf blade of grapevine

The volume of the fresh mass of the leaf blade is calculated from the *geometric proportion*:

The volume of the fresh mass of the leaf blade: volume of water = fresh mass of the leaf blade: mass of water.

$$V\ fr.m.of\ l.bl.\ of\ the\ cultivar\ Copaceac\ (y.2011) = \frac{V\ water\ x\ fr.m.of\ l.bl.}{m\ water} =$$

$$= \frac{20\ ml \times 3{,}9885 g}{20 g} = \frac{79{,}7700\ ml}{20} = 3{,}9885\ ml\ (=3{,}9885\ cm^3)$$

Stage 5. Determination of the volume of the dry mass of the leaf blade of grapevine

The volume of the dry mass of the leaf blade is calculated from the *geometric proportion*:

Volume of the dry mass of the leaf blade: volume of water = dry mass of leaf blade: mass of water.

Table 1

Biometric values of the morphobiological characters of the leaf blade, which determine the drought resistance of the species and cultivars of grapevine. Year 2011.

Name of the species or cultivar of grapevine	Fresh leaves			Dry leaves			Water		The degree of succulence, (%) of water mass from the average S (area) of the leaf blade	The degree of sclerophylly, (%) of the dry mass of the leaf blade from the average S (area) of the leaf blade	The percentage (%) of dry mass from the fresh mass of the leaf blade	The percentage (%) of 5 morphobiological characters of the leaf blade	The group of drought resistance of the grapevine
	The average area (S) of the leaf blade (in cm^2)	The average volume (V) of the leaf blade (in cm^3)	% V from S	The average area (S) of the leaf blade (in cm^2)	The average volume (V) of the leaf blade (in cm^3)	% V from S	The mass (in g)	% from the fresh mass of the leaf blade					
V. aestivalis Mich.	89,87	2,0939	2,33	89,87	0,5692	0,63	1,5247	72,81	1,70	0,63	27,19	32,48	4
V.amurensis Rupr.	77,78	2,1079	2,71	77,78	0,5974	0,77	1,5105	71,65	1,94	0,77	28,35	34,58	3
V.candicans Engelm.	47,93	1,1210	2,34	47,93	0,3460	0,72	0,7750	69,13	1,62	0,72	30,87	36,27	3
V.cinerea Engelm.ex Mill.	61,81	1,4478	2,34	61,81	0,4520	0,73	0,9913	68,47	1,60	0,73	31,53	36,93	3
V.cinerea Arnoldi	96,78	2,1834	2,25	96,78	0,6197	0,64	1,5637	71,61	1,61	0,64	28,39	33,53	3
Vitis monticola Buckl.	68,14	1,8974	2,78	68,14	0,5654	0,83	1,3320	70,20	1,95	0,83	29,80	36,18	3
V.romaneti Rom.	168,88	4,2745	2,53	168,88	1,3671	0,81	2,9074	68,01	1,72	0,81	31,99	37,86	2
V.silvestris Gmel.	78,22	2,2281	2,85	78,22	0,6866	0,88	1,5415	69,18	1,97	0,88	30,82	37,40	2
V.solonis	66,08	1,4178	2,14	66,08	0,4212	0,64	0,9812	69,20	1,48	0,64	30,80	35,70	3
V.vulpina L.	142,43	2,9777	2,09	142,43	1,0094	0,71	1,9683	66,10	1,38	0,71	33,90	38,79	2
Busuioacă	50,83	1,3814	2,72	50,83	0,4053	0,80	0,9761	70,66	1,92	0,80	29,34	35,58	3
Cabasma albă	95,56	2,9950	3,13	95,56	0,7971	0,83	2,1979	73,38	2,30	0,83	26,62	33,71	4
Ciorcuţa neagră	153,54	3,9129	2,55	153,54	1,1326	0,74	2,7803	71,05	1,81	0,74	28,95	34,79	3
Copciac	121,58	3,9885	3,28	121,58	1,3249	1,09	2,6636	66,78	2,19	1,09	33,22	40,87	1
Feteasca neagră	133,81	2,5563	1,91	133,81	0,8845	0,66	1,6718	65,39	1,25	0,66	34,61	39,09	2
Feteasca regală	167,60	3,2733	1,95	167,60	1,0660	0,63	2,2073	67,43	1,32	0,63	32,57	37,10	2
Negru de Acherman	123,48	4,1598	3,37	123,48	1,2900	1,04	2,8698	68,98	2,32	1,04	31,02	38,79	2
Plavae	135,97	4,2237	3,11	135,97	1,3922	1,02	2,8249	66,88	2,08	1,02	33,12	40,35	1

Agavam	232,00	5,5265	2,38	232,00	1,7179	0,74	3,8086	68,91	1,64	0,74	31,09	36,59	3
Concord	172,02	4,7234	2,75	172,02	1,3389	0,78	3,3845	71,65	1,97	0,78	28,35	34,63	3
Isabella	261,53	6,6388	2,54	261,53	2,0600	0,79	4,5788	68,97	1,75	0,79	31,03	36,90	1
Berlandieri-Riparia 420 A	157,58	3,9434	2,50	157,58	1,1434	0,72	2,8000	71,00	1,78	0,72	29,00	34,72	3
B-R-5BB	148,50	3,0312	2,04	148,50	0,9247	0,62	2,1065	69,49	1,42	0,62	30,51	35,21	3
DRX-55-F_2	62,80	1,6247	2,59	62,80	0,5363	0,85	1,0884	66,99	1,73	0,85	33,01	39,03	3
DRX-M_4-545	86,79	2,0153	2,32	86,79	0,5399	0,62	1,4754	73,21	1,70	0,62	26,79	32,05	4
DRX-M_4-583	79,85	2,1352	2,67	79,85	0,6475	0,81	1,4877	69,67	1,86	0,81	30,33	36,48	2
DRX-M_4-660	94,35	1,9790	2,10	94,35	0,6974	0,74	1,2816	64,76	1,36	0,74	35,24	40,18	1

Table 2

Biometric values of the morphobiological characters of the leaf blade, which determine the drought resistance of the species and cultivars of grapevine. Year 2012.

Name of the species or cultivar of grapevine	Fresh leaves			Dry leaves			Water		The degree of succulence, (%) of water mass from the S of the leaf blade	The degree of sclerophylly, (%) of the dry mass of the leaf blade from the average S (area) of the leaf blade	The percentage (%) of dry mass from the fresh mass of the leaf blade	The percentage (%) of 5 morphobiological characters of the leaf blade	The group of drought resistance of the grapevine
	The average area (S) of the leaf blade (in cm^2)	The average volume (V) of the leaf blade (in cm^3)	% V from S	The average area (S) of the leaf blade (in cm^2)	The average volume (V) of the leaf blade (in cm^3)	% V from S	The mass (in g)	% from the fresh mass of the leaf blade					
V.amurensis Rupr.	54,67	1,3738	2,51	54,67	0,3701	0,68	0,9108	66,30	1,66	0,68	33,70	39,23	2
V.californica Benth.	36,26	0,9558	2,63	36,26	0,3595	1,00	0,5963	62,39	1,64	1,00	37,61	43,88	1
V.monticola Buckl.	63,05	1,6188	2,56	63,05	0,4989	0,79	1,1199	69,18	1,78	0,79	30,82	36,74	3
V.rupestria Scheele.	35,43	0,8381	2,36	35,43	0,2881	0,81	0,5500	65,62	1,55	0,81	34,38	39,91	2
Vitis silvestris Gmel.	64,81	1,7278	2,66	64,81	0,5813	0,90	1,1465	66,35	1,77	0,90	33,65	39,88	2
Aligote	78,61	1,7644	2,24	78,61	0,5815	0,74	1,1829	67,04	1,50	0,74	32,96	38,18	2
Coarnă albă	78,47	2,0046	2,55	78,47	0,6246	0,80	1,2359	61,65	1,57	0,80	38,35	44,07	1
Coarnă neagră	81,25	2,7834	3,42	81,25	0,8730	1,07	1,9104	68,63	2,35	1,07	31,37	39,28	2
Copciac	99,48	2,6141	2,63	99,48	0,8417	0,84	1,7754	67,91	1,78	0,84	32,09	38,18	2
Feteasca albă	73,59	1,9995	2,71	73,59	0,6053	0,82	1,3942	69,72	1,89	0,82	30,28	36,52	3
Feteasca neagră	111,22	2,7182	2,44	111,22	0,9064	0,81	1,8118	66,65	1,63	0,81	33,35	39,04	2
Gordin	85,65	2,4278	2,83	85,65	0,7284	0,85	1,6994	69,99	1,98	0,85	30,01	36,52	3
Pino negru	66,98	1,6700	2,49	66,98	0,5532	0,82	1,1168	66,87	1,67	0,82	33,13	38,93	2
Rara neagră	110,05	3,2330	2,94	110,05	0,9850	0,89	2,2480	69,53	2,04	0,89	30,47	37,23	3
Şasla	44,21	0,9180	2,07	44,21	0,2863	0,65	0,6317	68,81	1,43	0,65	31,19	35,99	3
DRX-M_4-502	82,66	1,8849	2,28	82,66	0,5062	0,61	1,3787	73,14	1,67	0,61	26,86	32,03	4
DRX-M_5-20	81,79	1,6507	2,02	81,79	0,5347	0,65	1,1160	67,61	1,36	0,65	32,39	37,07	3
DRX-M_5-17	61,59	1,3108	2,13	61,59	0,4480	0,73	0,8628	65,82	1,40	0,73	34,18	39,17	2

$$V\ dry\ m.\ of\ l.bl.\ of\ s.\ Coarna\ neagra\ (y.2012) = \frac{V\ water \times dry\ m.of\ l.bl.}{m\ water} =$$

$$= \frac{25\ ml \times 2{,}7834\ g}{25\ g} = \frac{69{,}5850\ ml}{25} = 2{,}7834\ ml\ (=2{,}7834\ cm_3)$$

Stage 6. Determination of the degree of succulence of the leaf blade of grapevine

The degree of succulence of the leaf blade (Düring, Scienza, 1980; Культиасов, 1982) represents the ratio of the mass of water from the fresh mass of the leaf blade to the average area of the leaf blade.

Example. The degree of succulence of the leaf blade of the local grapevine cultivar Coarna neagră (2012) is 0.0236. [(1.9104 (g): 81.25 (cm^2)] = 0,0236)], (see tab. 2). But expressed as per cent (%) from the average surface (area) of the leaf blade, the degree of succulence = 2.36%.

(81.25 cm^2 ..... 100%

1.9104 (g) ..... x%; x = 2.36%).

Stage 7. Determination of the degree of sclerophylly of the leaf blade of grapevine

The degree of sclerophylly represents the ratio of the dry mass of the leaf blade to the average surface (area) of the leaf blade (Культиасов, 1982). This index shows the degree of development of the lignified tissues in the leaf blade at the studied species and cultivars of grapevine.

Example. The degree of sclerophylly of the leaf blade of the local grapevine cultivar Feteasca neagră (2012) = 0.0082. [(0,906 (g): 111,22 (cm^2) = 0,0082)]. But expressed as per cent (%) from the surface (area) of the leaf blade, this index = 0.81%.

(111.22 (cm^2) 100%

0.9064 (g) .....x%; x = 0.81%).

In the developed method, the higher total percentage of 5 morphobiological characters of the leaf blade (see tab. 1 and 2) determine the higher relative drought resistance of a cultivar or species of grapevine.

The addition of the percentages of the 5 morphobiological characters of the leaf blade to determine the relative resistance to drought of a cultivar or species of grapevine is legitimate because, for the xeromorphic leaves, the biometric values of the morphobiological characters of the leaf blade are higher (Баранов, 1946; Василевская, 1954; Düring, Scienza, 1980; Эзау, 1980; Культиасов, 1982). The dry mass of the leaf blade is also higher at the plants that are more resistant to drought (Третьяков, 1990).

At the local cultivar Copciac, the percentage of the 5 morphobiological characters

of the leaf blade, which caused its resistance to drought, was equal to 40.87% in 2011. This cultivar is the most resistant to drought, among the cultivars studied in 2011. The grapevine cultivar Plavae also belongs to the group I, with the highest relative resistance to drought (40.35%).

At the species *V.californica*, the dry mass of the leaf blade makes up 37.61% and in 2012, this species was the most resistant to drought. The total percentage of 5 morphobiological characters of the leaf blade of this species is equal to 43.88%. Only the local cultivar Coarna albă, in 2012, had a higher percentage (44.07%) of 5 morphobiological characters of the leaf blade.

CONCLUSIONS

1. The most drought resistant are those species, cultivars and hybrids of grapevine at which: the dry mass of the leaf blade is higher; the percentage of the volume of the fresh and dried leaf blade from the area of the fresh and dried leaf blade is higher; the degree of succulence and the degree of sclerophylly of the leaf blade are higher.

2. By the developed method, it is determined the relative drought resistance of 12 species of the genus *Vitis* L., 15 cultivars of the species *Vitis vinifera* L. (13 of which are local cultivars), 3 cultivars - direct producer hybrids, 2 rootstock cultivars and 6 distant hybrids of grapevine.

3. The most resistant to drought grapevine species and cultivars, in 2011, were *Vitis vulpina* (38.79%), *V. romaneti* (37.86%), *V. silvestris* (37.40%), Copciac (40.87%), Plavae (40.35%), Feteasca neagră (39.09%) and the distant hybrid DRX-M_4-660 (40.18%). In 2012, more resistant to drought are the species: *V.californuica* (43.88%), *V.rupestris* (39.91%), *V.silvestris* (39.88%), the grapevine cultivars: Coarna albă (44.07%), Coarnă neagră (39.28%), Feteasca neagră (39.04%) and the distant hybrid DRX-M_5-17 (39.17%).

4. The method for determining the resistance to drought of grapevine on the base of morphobiological characters of the leaf lamina can be used in the selection and introduction works in the Viticulture of the Republic of Moldova.

BIBLIOGRAPHY

1. Codreanu V. *Anatomia comparată a viţei de vie (Vtis* L.*)*. Combinatul Poligrafic. Chişinău, 2006.

2. Codreanu V. *Structura anatomică a laminei frunzei la unele specii de viţă de vie*. Studia Universitatis. Revista ştiinţifică a USM. Seria „Ştiinţe ale naturii", CEP USM. Chişinău, 2009. Nr. 6(26), p. 60-67.

3. Кодряну В. 2013. *Количественная анатомия листовой пластинки винограда (Vitis* L.). – Modern Phytomorphology 4: 199-207, 2013. 2nd Internaţional Scientific Conference on Plant Morphology (14-16 May 2013, Lviv, Ukraine). – Lviv, 2013. – Vol. 4:199-207.

4. Codreanu V., Savin Gh., Cornea V., Grigoraş V. 2008. Anatomia epidermei frunzei la unele soiuri de viţă de vie *Vitis vinifera* L. Studia Universitatis. Revista ştiinţifică a USM. Seria "Ştiinţe ale naturii", CEP USM. Chişinău, 2008. Nr. 7(17), p. 60-69.

5. Третьяков Н.Н. (ред.). Практикум по физиологии растений. Агропромиздат, Москва, 1990. С. 40-42.

6. Петраш Д. Ампелометрический метод. В кн.: Тимуш А.И. (ред.). Энциклопедия виноградарства, т. 1:80. Главная редакция Молдавской Советской Энциклопедии. Кишинев, 1986.

7. Ramadan T., Y.A.M.Omran. The effect of foliar application of methanol on productivity and fruit quality of grapevine cv. Flame seedless. – *Vitis* 44(1), 11-16, 2005.

8. Düring H., Scienza A. Drought resistance of some *Vitis* species and cultivars. – In: Proc. 3rd Int. Symp. Grapevine Breeding, 179-190. Dept. Vitic. Enol. Univ. California, Davis, 1980.

9. Культиасов И.М. Экология растений. МГУ. Москва, 1982.

10. Баранов П.А. Строение виноградной лозы. В кн. Фролов-Багреев А.М. (ред.). Ампелография СССР, т.1: 217-346. Пищепромиздат. Москва, 1946.

11. Василевская В.К. Формирование листа засухоустойчивых растений. Изд-во Туркменской АН ССР. Ашхабад, 1954.

12. Эзау К. Анатомия семенных растений. Книга 2. Мир, Москва. 1980.

THE INFLUENCE OF CLIMATE CHANGES ON PHENOLOGY TO SOME VARIETIES OF ROSES FROM BOTANICAL GARDEN "DIMITRIE BRANDZA"

Eduard Marius Negulici
University of Bucharest, Botanical Garden "Dimitrie Brandza"
Bucharest, Romania

Abstract. Like other species, roses are influenced by the climate changes. In this study we investigated how the roses from the Botanical Garden "Dimitrie Brandza" responded to climate variations during 2011-2013 and if there were important phenological differences and which were the most sensitive varieties of roses in the particular conditions that are specific in Bucharest and its surroundings.
Key words: climate changes, phenology, roses.

INTRODUCTION

Climate changes are more and more obvious and their impact on plants phenology is demonstrated in many situations (Andrew & al. 2012; Ryo Ishioka & al. 2012). For ornamental plants, knowledge of phenology changes determined by climate conditions is very important in the choice of the varieties intended for landscape improvements of parks and public gardens.

In the literature there are references to studies on the effects of climate change on plants. A study on the influence of winter temperatures on the flowering of the species *Prunus yedoensis* (the Japanese cherry) during 1947-2008 was conducted in the Wuhan University campus and there were recorded significant fluctuations since 2001 (Chen & al. 2008). Also, changes on phenological phases were studied by Ary A. Hoffmann, James S. Camac, Richard J. Williams, Warwick Papst, C. Frith Jarrad and Carl-Henrik Wahren on Australian subalpine plant species (Ary & al. 2010). A study on phenological changes in Japanese cherry species and other Japanese plant species was conducted in 2008 by Richard B. Primack, Hiroyoshi Higuchi and Abraham J. Miller - Rushing. Results showed that a more significant impact on phenology has been recorded in urban and southern areas.

Roses, like other species, are sensitive to both low and high temperatures,

associated with prolonged drought (Burzo & al. 2005). In this context, we investigated how the roses from the Botanical Garden „Dimitrie Brandza" responded to climate variations during 2011-2013, if there was a significant phenological difference and which were the most sensitive varieties in the particular conditions offered by the Municipality of Bucharest and its surroundings.

MATERIALS AND METHODS

There were 10 varieties studied as follows: 'Abraham Darby', 'Acapella', 'Angela', 'Caprice Meilland', 'Christoph Columbus', 'Forever Young', 'Heritage', 'Ingrid Bergman', 'Rhapsody in Blue' and 'Red Berlin'. The main criteria for the choice of varieties were: to be created after 1980 to have a new assortment; to be part of as many groups of flowering, to have diversity; to have adequate ornamental and biological characteristics, suitability for use in green spaces in Bucharest area. For each variety were conducted observations on a number of five individuals. The main phenophases noted were: burgeoning, leafing, budding and flowering. Climatic data were taken from the INMH-Bucharest Center, time benchmark is 14.00. Also the minimum temperatures on the winter period 2011-2013 were recorded (Figs 1-3).

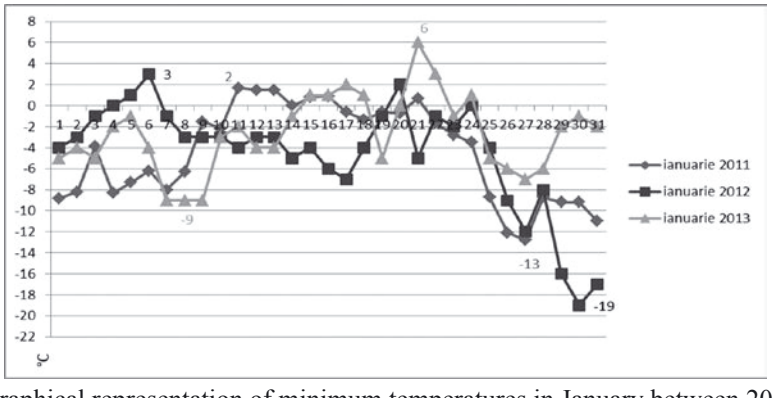


Fig 1. Graphical representation of minimum temperatures in January between 2011-2013

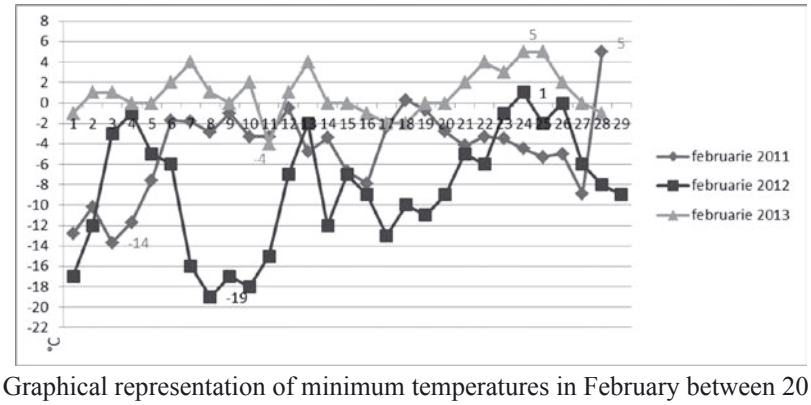


Fig. 2. Graphical representation of minimum temperatures in February between 2011-2013

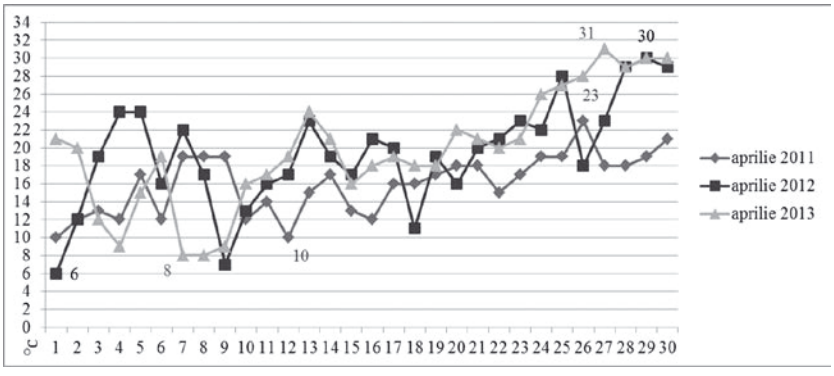


Fig. 3. Graphical representation of temperatures at 14 PM in April between 2011-2013

RESULTS AND DISCUSSIONS

The earliest values were recorded in 2011 for the burgeoning and leafing phenophases (Table 1). In the case of burgeoning, it can be observed that the variety 'Caprice de Meilland' presented an earliness in 2011 (14 March), unlike 2012 when it showed a general delay. In the case of leafing, the earliest values during the period studied were recorded in 2011. In the case of budding, the varieties showed an earliness in 2012 compared to the previous 2 years, with a difference of up to 26 days in the variety 'Rhapsody in Blue' (24 May 2011). Also, in 2012, flowering was earlier during the study period, the representative variety being 'Forever Young' (5 May 2012). In terms of number of days between the burgeoning phenophase and the other two stages, budding and flowering, it can be observed: the highest values were recorded in 2011 and the lowest in 2012 (Table 1).

Interestingly, in 2012 the burgeoning occurred the latest of the three years because of minimal thermal values of up to -19 degrees in the winter (30 January and 8 February), but after the daytime heat waves of up to 30° C (April 29), the number of days between burgeoning and budding, respectively flowering was lower (Table 1).

CONCLUSIONS

Varieties for which there were recorded small phenophases variations in climatic conditions during 2011-2013 are: 'Heritage', 'Caprice Meilland', 'Christoph Columbus', 'Ingrid Bergman' and 'Angela'. They can be used successfully in the conditions offered by Bucharest and its surroundings. In future, we intend to continue the investigation and the completion of the data obtained until now, to have a more complete picture of the impact that climate changes could have on the varieties of roses grown in Bucharest.

The climatic conditions of spring 2012 have led to an earlier growing start up

Table 1

The main phenophases during 2011-2013

Nr.	Variety	(1) Burgeoning			(2) Leafing			(3) Budding			(4) Flowering			Nr. of days between phenophase (1)-(3)			Nr. of days between phenophase (1)-(4)		
	Year	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
1	Abraham Darby	15.03	26.03	17.03	29.03	05.04	12.04	11.05	30.04	25.04	24.05	13.05	9.05	57	34	39	70	47	53
2	Heritage	15.03	26.03	17.03	29.03	05.04	11.04	**09.05**	30.04	3.05	25.05	15.05	20.05	**55**	34	47	71	49	64
3	Forever Young	15.03	24.03	18.03	29.03	05.04	13.04	10.05	30.04	**25.04**	**19.05**	**05.05**	**8.05**	56	32	38	**65**	**42**	**51**
4	Rhapsody În Blue	15.03	24.03	18.03	31.03	04.04	13.04	**24.05**	30.04	29.04	**07.06**	13.05	16.05	**70**	**32**	42	**84**	50	59
5	Acapella	15.03	26.03	**18.03**	29.03	05.04	**14.04**	17.05	01.05	**9.05**	30.05	18.05	21.05	63	**35**	52	76	**52**	64
6	Caprice de Meilland	**14.03**	26.03	17.03	29.03	05.04	12.04	11.05	30.04	26.04	24.05	14.05	20.05	56	34	40	69	48	64
7	Christoph Columbus	**16.03**	26.03	**16.03**	31.03	05.04	**10.04**	14.05	30.04	**9.05**	30.05	**20.05**	**23.05**	59	34	**54**	75	54	**68**
8	Ingrid Bergman	15.03	25.03	18.03	29.03	05.04	13.04	13.05	30.04	25.04	26.05	16.05	**23.05**	59	35	**38**	72	51	66
9	Red Berlin	15.03	24.03	16.03	31.03	04.04	11.04	15.05	30.04	30.04	26.05	13.05	18.05	61	32	45	72	50	63
10	Angela	15.03	24.03	16.03	29.03	04.04	12.04	12.05	01.05	30.04	23.05	13.05	16.05	58	33	45	69	49	61

compared to the same period of 2011. The maximum difference was recorded in the variety 'Caprice Meilland', 12 days at burgeoning in 2012 compared to 2011.

Also in 2012 it was recorded a shortening of the intervals between the budding phenophase and the blossoming and flowering phenophases as well as between the leafing and blossoming.

BIBLIOGRAPHY

1. Wagner, Ş., *Trandafiri cu parfum*, Editura Napoca Star, Cluj-Napoca, 2010.
2. Iliescu, A.F., *Cultura arborilor şi arbuştilor ornamentali*, Editura Ceres, Bucureşti, 2002.
3. Grant, A.W., *Botanica's Pocket-Roses*, Random House Australia, 2004.
4. Chen Zhenghong, Xiao Mei, Chen Xuan, *Change in flowering dates of Japanese Cherry Blossoms (P. yedoensis Mats.) on campus of Wuhan University and its relationship with variability of winter temperature*, ACTA ECOLOGICA SINICA, Volume 28, Issue 11, November 2008.
5. Ary A. Hoffmann, James S. Camac, Richard J. Williams, Warwick Papst, Frith C. Jarrad and Carl-Henrik Wahren, *Phenological changes in six Australian subalpine plants in response to experimental warming and year-to-year variation*, Journal of Ecology 2010, 98, 927–937.
6. Richard B. Primack, Hiroyoshi Higuchi, Abraham J. Miller-Rushing, *The impact of climate change on cherry trees and other species in Japan,* Biological Conservation 142 (2009) 1943–1949.
7. Ryo Ishioka, Onno Muller, Tsutom Hiura, Gaku Kudo, *Responses of leafing phenology and photosynthesis to soil warming in forest-floor plant*, Acta Oecologica 51 (2013) 34-41.
8. Andrew D. Richardsona, Trevor F. Keenana, Mirco Migliavaccab, Youngryel Ryua, Oliver Sonnentaga, Michael Toomeya, *Climate change, phenology, and phenological control of vegetation feedbacks to the climate system*, Agricultural and Forest Meteorology 169 (2013) 156– 173.
9. Burzo I. şi colab., *Fiziologia plantelor,* Editura Elisavaros, Vol IV, VII. 2005.

QUANTITATIVE ANATOMY OF LEAF EPIDERMIS AT INTERGENERIC TETRAPLOID HYBRIDS QUINCE X APPLE (CYDONIA X MALUS)

Elisaveta Onica

Botanical Garden (Institute) of the Academy of Sciences of Moldova, Chisinau, 18 Pădurii str., MD-2002, Republic of Moldova

Abstract. The paper attest the quantitative peculiarities of leaf epidermis at the intergeneric hybrids, quince x apple.

Key words: quantitative anatomy, leaf, epidermis hybrid, osteolar index.

INTRODUCTION

The revealing of leaves' structural peculiarities at *Cydonia* x *Malus* distant hybrids which distinguish after genotype and resistance to biotic and abiotic factors represent an interest for deeply knowing the biological properties of the hybrid forms which is actual for pomiculture. The peculiarities of epidermal leaf structure of tetraploid hybrids, quince x apple, which grow and develop at the Botanical Garden (Institute) of A.S.M. are described in this paper. The differences, qualitative and quantitative, of the epidermal leaf in 7 *Cydolus* hybrid forms, in comparison with genitors and other hybrid plants are emphasized.

The preparation of microscopic sample obtained from the leaf surface replica, moreover further study according to the methodics was performed [1, 2].

MATERIALS AND METHODS

As objects of the study, the mature leaves from the midst of the crown, collected from 7 intergeneric hybrids quince x apple, of which biological material was taken from Botanical Garden's collection, but parental forms of quince (Turunciuc sort) and apple (Jonathan sort) from S.P.A. 'Codru' served. The density, morphology and biometry of the epidermal cells and of stomata in the collodion replicas were studied. The 4 per cent collodion solution was utilized, having the target of preparing

the abaxial and adaxial epidermis replicas of leaves at 7 *Cydolus* distant hybrids, in comparison with the genitors and other hybrids included in study. For obtaining the micro-sample of desired leaf sector, with a fine smoothie dipped in 4% solution of collodion, we draw a line of 1-3 cm length per the central part of the leaf from the middle annual stalk. After the micro-sample was dried, in 3-4 minutes, we broke the leaf from the plant and it was herbarized.

The preparing of micro-sample achieved from the foliar surface, also the ulterior study, according the methodics [1, 2, 5, and 6] were performed. The study results concerning quantitative anatomy of abaxial and adaxial leaves at hybrid plants with diverse level of polyploidy were statistically processed according to methods [3].

RESULTS AND DISCUSSIONS

Hypo-stomatal leaf at tetraploid hybrids, which were included in the present research, has a dorsiventral structure like at those initial forms. Adaxial epidermis from a single row of flat cells is compound; they are tangentially elongated with rectilinear contour and compactly situated. Abaxial epidermal cells are distinguished from those of adaxial epidermal cell by form, dimension, and thickness of cell membrane and of cuticle. Abaxial epidermis of leaf of hybrid plants studied, as well as initial forms, is compound of many components, so epidermal nomophylle cells of polygonal form, which possess a sinusoidal profile; stomata which are formed from two reniform stomatal cells are positioned tête-á-tête; annex cells and hairy-leaved of different form and size. The stomata, together with secondary cells, stomatal complex of anomocit type are formed.

Tetraploid hybrids are distinguished from the diploid and triploid plants by epidermal cells of lager dimensions both in radial direction (45-50 μm), and in that of tangential (25-29 μm). The medium length of leaf epidermal cells at the diploids was 23-37 μm, while the width – 14 and 22 μm, while the length of cells at parental forms reached 34-38 μm, and their width achieved 19 to 24 μm (Table 1). The triploids occupy, after the above-mentioned parameters, an intermediate position between tetraploid and diploid [4, 5]. The same regularity at the studied hybrids concerning such anatomical characters as the stomata and aperture dimensions was identified.

The results of investigations attest concerning the existence of direct correlative dependence (r= 0.6-0.8) between the polyploid level at the intergeneric hybrids, quince x apple, and the dimensions cells epidermis adaxial and abaxial of stomata and ostiole. However, a correlative indirectly proportional dependence into the multiplicity level and stomatal frequency of epidermal abaxial and adaxial cell per unit of foliar area (r= 0.5-0.6) is registered. Stomatal density per 1 mm^2 of foliar area at tetraploid was 357-420, diploid – 471-663, triploid – 419-551, meantime at apple was equal to 716 and quince – 855 stomata.

Table 1

Quantitative anatomy of the leaf lamina epidermis at intergeneric hybrids F_1-F_2 quince x apple (*Cydonia* x *Malus*)

The initial forms and hybrids	Nr. of chromosomes	Adaxial epidermis		Abaxial epidermis		Number of cells per 1 mm² of surface		Stomatal aperture length	Number of stomata per 1 mm² of surface	Index of osteole
		Cells length	Cells width	Cells length	Cells width	Inferior epidermis	Superior epidermis			
Quince (Turunciuc)	34	33,8 ± 0,9	19,0±0,8	29,5±0,9	17,6±0,7	1970±5,0	1995±3,1	14,6±0,4	855±5,6	30,3
Nr 1-72	68	50,2 ±1,1	29,9±0,9	46,7±1,3	23,5±0,6	1288±6,0	1181±8,5	22,4±0,7	357±3,6	21,7
33-72	68	44,8 ±1,2	26,3±0,9	42,5±1,9	22,1±1,2	1442±4,0	1203±5,0	19,6±0,5	369±9,1	20,4
F_2 nr 25	68	46,5 ±1,9	25,3±0,8	36,7±0,9	23,4±1,3	1549±3,0	1203±7,0	19,2±0,5	420±5,2	21,3
Nr 1-69	51	39,3 ±1,7	25,4±0,9	36,6±1,1	21,4±1,3	1724±8,0	1381±4,0	17,4±0,5	540±4,0	23,9
18-72	51	38,2 ±1,1	21,8±0,8	37,2±1,5	20,4±1,2	1792±5,0	1782±3,0	17,4±0,4	551±6,3	23,5
13-72	51	40,5 ±1,5	25,4±0,8	36,6±1,3	19,3±0,9	1770±2,0	1278±5,0	18,4±0,6	545±8,0	23,6
Nr 2-69	51	43,2 ±0,9	26,3±0,8	34,5±1,2	16,5±0,8	2161±5,0	1710±3,0	19,8±0,7	419±8,4	16,2
Nr 4-72	51	43,2 ±0,8	26,3±0,9	34,9±1,3	16,4±0,7	2159±4,0	1592±3,0	19,6±0,3	481±9,3	18,2
Nr 7-72	51	40,2±1,2	24,7±0,7	40,1±1,1	18,0±0,9	1835±2,0	1681±2,0	21,3±0,5	475±6,0	20,6
Nr 4-74	34	23,4±1,2	14,1±0,5	22,3±1,1	11,2±0,6	2482±9,0	1935±7,0	12,7±0,4	471±5,4	15,9
F_1 nr 1	34	37,2±37,2	22,3±0,8	34,9±1,3	18,7±0,9	2277±9,0	1934±7,0	17,5±0,5	523±6,2	18,7
F_1 nr 25	34	33,2±1,3	18,9±0,8	31,3±1,2	18,9±0,9	2192±9,0	1767±9,0	16,1±0,5	663±7,9	23,2
Malonia	34	34,9±1,2	21,6±0,9	32,2±0,9	20,6±0,8	2156±11,0	1660±7,0	18,9±0,4	509±9,2	19,1
Apple (Jonathan)	34	38,3±1,4	23,6±0,7	30,2±0,9	14,1±0,7	2070±12,0	1984±9,0	18,9±0,7	716±7,1	15,9

CONCLUSIONS

1. The studied hybrids are distinguished between them *quantitatively* after following characters: epidermal cell dimensions, stomatal dimensions, aperture dimensions, adaxial and abaxial epidermis cell density per 1 mm^2 of foliar surface (area) and stomatal density per 1 mm^2 of foliar surface (area).

2. Superior (adaxial) epidermis cells of the leaves at tested hybrids have polygonal shape and the cellular walls erect (rectilinear), also poly-angular projection, but inferior (abaxial) epidermis cells have the sinuous contour.

3. The results of the investigation confirm that between the ploidy level, at the intergeneric hybrids, quince x apple, and adaxial and abaxial epidermis cell dimension, stomata and ostioles dimension there are a correlative direct dependence (r= 0.6-0.8) and a correlative indirect populational dependence between the level of multiplicity and the stomatal frequency, of abaxial and adaxial, epidermis cells per 1 mm^2 of foliar surface (r= 0.5-0.6).

4. The investigated hybrids between it after such characters as epidermal cell dimensions, aperture, stomata and the number of cell and stomata per 1 unit of foliar surface are distinguished.

5. After the value of osteolar index the distant hybrids, quince x apple, occupies an intermediate position, in fact permit us emphasize that above-mentioned hybrid plants inherit this character from the both genitors.

6. The quantitative anatomical characters in supplementary testing of hybrid biological resistance in early stage can serve, in the process of plant breeding' which belong to *Pomoideae* subfamily, *Rosaceae* family may be used.

BIBLIOGRAPHY

1. Codreanu V. Anatomia comparată a viţei de vie (*Vitis* L.). Chişinău, 2006. 252 p.

2. Захаревич С.Ф. К методике описания эпидермиса листа. In: Вестник ЛГУ. Сер. биол.1954, 4, с. 65-75.

3. Лакин Г.Ф. Биометрия. Изд. 4-е. М.: Высшая школа, 1990.

4. Негру Е.И.Руденко И.С. Особенности анатомического строения черешка и листа разногеномных гибридов айва х яблоня. In:Тез. докл.1 Всесоюз. конф. по анатомии растений. Л.1984.с.114-115.

5. Оника Е.И. Особенности анатомической структуры гибридов айва х яблоня. Автореф. дисс. канд. биол. наук. Кишинэу, 1993, 20 с.

6. Соколов В., Шумный В., Цанев Ц., Станев В., Данаилов Ж., Добринова К. Частота, размер и функциональные характеристики устьиц в связи с гетерозисом у гороха. In: Изв. Сиб. Отд. АН СССР, Сер. Биол. науки, 1988, 14(464), вып. 2, с. 89-94.

EMBRYOLOGICAL APPROACH OF EXPERIMENTAL WALNUT POLLINATION

Maria Pintea
Research Institute for Horticulture and Alimentary Technologies, Chisinau, Republic of Moldova

Abstract. Embryological researches of experimental pollination of walnut (*Juglans regia* L.) pistillate flowers on different phases of stigma opening reveal that it is receptive to pollination during 6 days. In the frame of dichogamy the most favourable for fertilization morphophysiological state of embryo sac comes in 2-3 days. It is established that Moldavian protandrous varieties, have a shorter receptivity period comparatively to protogynous ones. The most efficient pollinators for establishment of local orchards there are established.

Key words: embriology, walnut, pollination.

INTRODUCTION

Sustainable fructification of walnut varieties depends on different factors. One of the most important problems is effective pollination and fruit set (1, 2, 5, 6). In this paper are presented the results of researches of the morphological and hystochemical peculiarities of pistillate flower receptivity to pollination depending on flowering stage. Studies were done with the scope of determination of the terms of more effective period of pollination within dichogamous (protandrous, protoginous and homogamous) varieties in the conditions of Republic of Moldova.

MATERIALS AND METHODS

16 Moldavian dichogamous varieties and perspective selections were experimented in direct and indirect hybridisations (including hand auto pollination). On the basis of utilisation of cytoembryiological, including hystochemical methodology (3, 5, 6) were tested dynamic of contents and localisation of enzymes, pollysaccharides, proteins and nucleic acids (DNA and RNA) in the principal parts of pistillate flowers.

RESULTS AND DISCUSSIONS

Morphological and histochemical investigations of dichogamous walnut experimentally pollinated flowers in different phases of stigma opening showed the following results. Histochemical studies of the development of ovule "packing tissue" reveal its high metabolic activity in progamic fertilization phase, which may confirm chalazogamy manifestation. Experiments indicate that usually numerous pollen grains of protandrous, protoginous and simultaneously flowering genotypes germinate on the stigma but only some of pollen tubes penetrate the ovules. However, at a significantly lower percentage than differences recorded in the optimal proportions suggesting that stigmatic receptivity as well as embryo sac vitality are clearly the limiting factors of flower receptivity [2, 5].

Morphophisiological researches of stigma vital activity and integral flower receptivity to pollination of dichogamous genotypes which are differrent according the receptivity within whole pistillate flower to pollination demonstrate that there are susceptible differences beetween protandrous, protoginous and partially homogamous (simultaneously flowering) genotypes (tab.1, 2). Likewise, it has been identified that all genotypes with late period of flowering have more prolonged period of phisiological activity of embryo sac (tab.2). Experimental self pollination confirms the possibility of self-compatibility of walnut genotypes irrespective of flowering type. It should be noted also that protogynous varieties in this case have a higher fertilization percent of fruit set.

Cross pollination of protandrous, protogynous, and simultaneously flowering varieties (in direct and indirect croses) shows a high combination ability of most studied varieties.

At the same time, luminescent – and histochemical analysis of free pollination shows morphophysiologically different quality flowers of solitary growing genotypes, which, however, at optimal orchard establishment and agronomical practices scarcely affect fruit-bearing rate.

Experimental investigations, dedicated to the studies of the morphophisiological state of the pistillate English walnut flower artificially pollinated at different stages of development of stigma, including main structures of gynoecium demonstrate the following characteristics. Three days before the complete stigma opening, flowers are not receptive for the process of pollination, when are not possible mass germination of pollen grains on the stigma. The same situation is found up during the 6 days of anthesis, stigma structures could not ensure pollen germination and growth of pollen tubes, but in this case because another situation: morphophisiological „lost" of receptivity. Histochemical test of enzymes and proteins shows the same level of activity in the stigma tissue 3 days before the flowering as well as in the first 3 days of the flowering (stigma opening and increasing of papillae). We noticed that in the third days of flowering it is evaluated the presence of the most quantity of granules of polysaccharides

in the stigma tissues. According to our embryological results of researches and on the base of obtained biochemical investigations of pistillate walnut flowers of the same varieties we can consider that this group of substances - polissacharides, have the predominant role for the growth of pollen tubes. It was determined an optimal pollen tubes germination and growing in the stigma and partially style tissues. But in such cases there is compromised double fecundation because of non maturation of the elements of embryo sac. As a result of morphological and histochemical investigations it was demonstrated that the most favourable morphophisiological state is going 2-3 days after the differentiation of its 7 cells, approximately during the 4-5 day after the total development of stigma tissue. We could suppose that late morphophisiological maturation of female gametophyte could be provoked by the absence of porogamy in the family *Juglandaceae.* Therefore, walnut embryo sac longevity is limited to 3-5 days. This fact is confirmed by the situation that in the case of pollination of the flowers in the 6-th days of pollination, pollen tubes reach the apical of ovule in the 9 and 10 days. Physiologically, at this time, the embryo sac already "lost" the capacities for double fecundation. Morphological and cytochemical changes of polar nucleus very eloquently could demonstrate different physiological state of embryo sac. So, if in the first days of flowering polar nuclei are very close situated, in the nine –ten days, it is observed already its fusion.

Therefore, we could conclude that when pollination is effectuated 3 days before complete flowering, as well as in the third and ninth days of flowering, stigmatic non receptivity is connected with insufficient physiological development of embryo sac. In case of pollination in the first day of flowering, stigmatic tissues are receptive to pollen and pollen tubes, but embryo sac is not ready for pollen tubes with gametophyte. The most favourable state for pollinations is created in the third day of flowering for the varieties with medium period of flowering. But in this situation stigmatic receptivity totally corresponds with physiological preparation of female gametophyte to fertilization. Relevant aberrations of these terms could be in the cases of medium period of female flowering, which depends on genotype, type of dichogamy, thermal condition of flowering period.

Considering the data of morphophisiological characterisation of the receptivity of embryo sac and elements of gametophyte we suggest that in the microclimatic conditions of the Republic of Moldova the most chance for efficient double fertilization have genotypes with simultaneously flowering of male and female flowers as well as early flowering protoginous genotypes.

The obtained morphological and histochemical data demonstrate that walnut pollen with pistil developed reciprocal system of co-adaptation. Thus, relatively rapid growth of pollen tubes in the pistil tissues is facilitated by specific structure of tissue as well as by the presence of large quantity of polysaccharides. It was evaluated that during the gametogenesis, as well as in the period of maturation of zygote in tegumental

„packing" tissue there are reserved high quantity of polysaccharides and enzymes. We suggested that this tissue functionally could be considered a real obturator. In addition, the obtained data revealed that marginal adjacent tissues are very similar histochemically with tegumental „packing" tissue – a demonstration that there is present possibility of function of signalling of direction of pollen tube growing.

It is possible to consider that in the evolutionary processes the central structural and physiological part of walnut ovary adapted to halazogamy. Thus, intercellular penetration of pollen tubes into the ovary transmitting tissue is changed via another way of penetration in the ovule direction, – among „packing tissue" which ensured the possibility to intensive development. In our opinion, walnut aporogamy could be influenced additionally by manifestation of gametophitic compatibility. Likewise, the penetration of more than one pollen tube at the level of nucellus and the following absence of double fecundation could be explained by the manifestation of incompatibility barrier at the level of ovule, or even in the embryo sac. The most distinguishable characteristics between the elements of embryo sac in the frame of dichogamy there are found prior to double fecundation, especially for egg apparatus. In the same time, antipodial cells did not show morphophisiological differences at the level of varieties as well as in the frame of dichogamy (especially during gamogenesis). We noticed that processes of dezintegration of antipodial cells are very similar with the same that are observed in the tapetal tissue in the anthers.

Our investigations demonstrate that stigma receptivity of walnut flower to the optimal pollen germination and normal pollen tubes development in stigma tissues are possible during 6 days of flowering time. But the embryo sac reaches the most favourable physiological state for double fecundation after 2-3 days of the formation of 7-cell state. As a rule this moment coincides with 4-5 days of opening of stigmatic parts. Therefore, we could conclude that an effective viability of embryo sac is available in the limits of 3-5 days.

Table 1

Fecundation and fruit development after walnut experimental pollination at different stage of pistillate flower development

Variant of pollination	Number of studied flowers/specimens	% of fecundation case	Number of studied flowers/in the field	% of fruit setting
3 days before anthesis	40	5,00	87	2,29
In the 3 days of flowering	30	6,66	262	1,09
In the 6 days of flowering	40	65,00	255	54,11
In the 9 days of flowering	40	62,50	282	51,60

Table 2

Average period of functional activity of walnut embryo sac in relation with the type and flowering period of genotype

Type and flowering period of genotype	Flowering period (days)	Duration of functional activity of walnut embryo sac
Simultaneous		
Early flowering	8	5-6
Protoginous		
Late flowering	6	5-6
Early flowering	6	3-5
Protandrous		
Early flowering	4	2-3
Late flowering	6	3-4

Comparative analysis of data obtained in the field experimentations as well as on the cyto and histochemical specimens shows that durations of the stigma opening (real flowering period) there are different for protoginous, protandrous and simultaneously varieties (tab. 2). On the basis of effectuated experiments it is possible to propose the combinations basic variety x pollinator for the establishment of new country orchards (tab. 3). Likewise, in the frame of dichogamy there is created a different period of longevity of the embryo sac. Maturation of egg apparatus and sinergides is directly related to this process. General reflections there are in the favour of predominant spread of the phenomenon of walnut intra-specific cross pollination. Likewise, these processes could be related to diversification and evolution of the gene pool of the species *Juglans regia* L.

It is concluded that the most favourable morphophysiological state of embryo sac for fertilization is coming in 2-3 days after the differentiation of 7-cells stage. This moment coincides approximately with the 4-5 day of total opening of stigma. For the protoginous genotypes with the medium flowering period the most favourable stage for pollination is coming on the third day of flowering. In this case, the efficient receptivity of stigma totally corresponds to morphophysiological preparation of female gametophyte for fertilization. Data of dynamics of differentiation processes within dichogamy make us to conclude that in the climatic conditions of the Rep. of Moldova the genotypes with simultaneous dates of flowering of male and female flowers, as well as the early protoginous genotypes have the most chances for occurrence of double fertilization and for the following normal development of the embryo as a principal and more valuable part of walnut fruit.

Table 3

Effective pollination of walnut varieties in the new established orchards

The basic variety / as a rule it represents about 80 % trees/	Pollinator variety
Kalaraskii	Kostiujenskii, Korjeuţkii
Korjeuţkii	Kalaraskii, Kostiujenski
Kostiujenskii	Skinosskii, Kalaraskii, Kisinevski, Kostiujenskii,
Skinosskii, Kogâlniceanu	Korjeuţkii
Kazacu	Kostiujeni, Korjeuţkki
Kisinevski	Kostiujenskii, Kisinevski, D-5, Franquette

CONCLUSIONS

1. Experimental direct and indirect pollination of walnut *(Juglans regia* L.*)* pistillate flowers on different phases of stigma opening reveals that it is receptive to pollination during 6 days.

2. The most favourable for fertilization morphophysiological state of embryo sac comes in 2-3 days after it reaches 7-cells state. As a rule this status corresponds to the 4-5 day after the beginning of stigma opening.

3. In the microclimatic conditions of the republic of Moldova protandrous varieties, as a rule, have a shorter receptivity period comparatively to protogynous ones.

4. There where established the most efficient combinations of varieties (basic variety x pollinator) for the establishment of new Moldavian walnut orchards.

BIBLIOGRAPHY

1. Comanici I., 1980. I.G. *Biologhia, culitura, selecţia greţcogo oreha*. Kishiniov, 142 p.

2. E. Gratacós, P. Brauchi, R. Herrera, 2006 – *Flowering in walnut (Juglans regia L.) cv Serr for increased productivity in central Chile*. Hortscience. 2006, vol. 41, nº7, pp. 1537-1540.

3. Jensen W., 1965 – Botaniceskaia ghistohimia. Per. s angl. Moskva, Nauka. 377 s.

4. Kho J. O., Baer J., 1968 – *Observing pollen tubes by means of fluorescence*. Euphytica. Vol. 17.-N2.-P. 298-302.

5. Pintea M. A., 2004 – *Nucul. Biologia reproductiva***.** Chisinau. 364p.

6. Rădulescu-Mitroiu N., 1976 – *Embriologie vegetală*, Bucureşti. 299 p.

THERAPEUTIC IMPORTANCE AND THE INFLUENCE OF SOWING DENSITY ON SOME PRODUCTIVITY ELEMENTS TO OAT *(AVENA SATIVA)* SPECIES IN A.R.D.S. SECUIENI CLIMATIC CONDITIONS

Traian Ioan Pomohaci, Margareta Naie, Simona Florina Pochişcanu, Cătălina Druţu, Lorena-Diana Popa, Oana Mîrzan

Agricultural Research – Development Station Secuieni, România

Abstract. Oats are one of the most important cereals, known since the fourth century B.C., as an exceptional energizing for the cold and wet season (Mogârzan Aglaia, 2004). Currently, it is widely used as a flakes, which are more digestible and tastier than those of barley, being recommended especially for: hypothyroidism, sterility and impotence adjunct, sensitivity to cold, sand at gallbladder and kidneys, reduce the cholesterol, regulate the activity of heart and helps digestion (Ciuculin V. 2006). This paper intends to realize some researches about the influence of seeding density and distance between rows on the number of grains in the panicle, panicle weight and 1000 grain weight at the oat species (Avena sativa). Due to the researches, were revealed the highest values of all three productivity characters that were obtained to the variant with the sowing density of 75 g.s./m^2 and the distance between the rows of 37.5 cm. The lowest average of the grain number per panicle was 25.17 and the highest was 32.57 grains. The lowest weight of panicle seeds was 0.68 g and the highest was 1.04 g. The lowest value of 1000 grain weight was 30.28 g and the highest value was 35.20 g. It was observed that the values of all three productivity elements are directly proportional with the distance between rows and inversely proportional to the number of germinable seeds sown per square meter.

Key words: oat, grains, seeding density, distance between rows.

INTRODUCTION

Oats are one of the most important cereals, known since the fourth century B.C., as an exceptional energizing for the cold and wet season *(Mogârzan Aglaia, 2004)*.

Nutritionally, oats is one of the most complex foods because its content is slow absorption carbohydrates from fibers, proteins, minerals and vitamins.

Oat grains are an excellent concentrated forage irreplaceable in feed of horses, cattle and sheep for reproduction, for young animals subjected fattening, dairy cows and poultry (*Armstrong D.G., and Finlayson H.J., 1992*).

Currently, it is widely used as a flakes, which are more digestible and tastier than those of barley being recommended especially for: hypothyroidism, sterility and impotence adjunct, sensitivity to cold, sand at gallbladder and kidneys, reduce the cholesterol, regulate the activity of heart and helps digestion *(Ciuculin V. 2006)*.

Oats are known for its capacity to decrease cholesterol level and prevent absorption of other unhealthy fats in the body. With the decrease of cholesterol level, the blood pressure decrease and clogging of the arteries is impeded. Thus, people who regularly consume oats have a high chance to prevent cardiovascular disease.

Also oats are an ideal food for people who have a slow intestinal transit and reduce the risk of colon cancer, thanks to the fibers which absorb the toxins and substances which could cause tumors in their way *(www.sfatulmedicului.ro)*.

MATERIALS AND METHODS

This paper intends to present some results of the researches about the influence of seeding density and distance between rows on the number of grains in the panicle, panicle weight and 1000 grain weight at the oat species *(Avena sativa)*.

The seed used in the experience was Mureş variety with very good qualitative indices (power of germination 94%, biological purity 99.7% and the 1000 grain weight, 32 g).

In the spring of 2013, within the ARDS Secuieni, on a typical cambic chernozem, was an experimental field established, by the „subdivided parcels" method, with random variants, which was bi-factorial, AxB type.

Factor A represent the distance between rows with three graduations (12.5 cm, 25 cm and 37.5 cm) and factor B represent the sowing density with five graduations for each distance between rows: for 12,5 cm distance between rows, 600 g.s./m^2, 500 g.s./m^2, 400 g.s./m^2, 300 g.s./m^2, 200 g.s./m^2, for 25 cm distance between rows, 300 g.s./m^2, 250 g.s./m^2, 200 g.s./m^2, 150 g.s./m^2, 100 g.s./m^2 and for 37,5 cm distance between rows 225 g.s./m^2, 188 g.s./m^2, 150 g.s./m^2, 113 g.s./m^2, 75 g.s./m^2.

RESULTS AND DISCUSSIONS

The relation between these two variables (sowing density and productivity elements) is inversely proportional.

This demonstrates that the values of the grains number per panicle, the grain weight per panicle and the 1000 grains weight are decreasing at the same time with the increasing the number of plants/m^2.

Regarding the influence of sowing density on the number of seeds in the panicle, for 12.5 cm distance between rows, the variant sown with 200 g.s./m^2, recorded a difference of 2.80 seeds compared to the control and a value of that is significant positive.

For 25 cm distance between rows, compared to the control, only the variant sown with 100 g.s./m^2 is statistically assured, being distinct significant positive, and for 37.5 cm distance between rows, the variant sown with 150 g.s./m^2 is significant, the variant sown with 113 g.s./m^2 is distinct significant and the variant sown with 75 g.s./m^2 is very significant (*Table 1)*.

Table 1

The influence of sowing density on the number of grains in the panicle

Distance between rows (cm)	Sowing density g.s./m²	Number of grains in the panicle	% compared to control	Differ-ence	Semnif.		
12,5	**600**	25,17	97,81	-0,56			
	500	25,73	100,00	Mt		**LSD 5%=**	2,0
	400	25,77	100,14	0,04		**LSD 1%=**	3,0
	300	26,90	104,55	1,17		**LSD 0,1%=**	4,4
	200	28,53	110,90	2,80	*		
25	**300**	27,90	98,59	-0,40			
	250	28,30	100,00	Mt		**LSD 5%=**	1,4
	200	29,20	103,18	0,90		**LSD 1%=**	2,0
	150	29,63	104,71	1,33		**LSD 0,1%=**	3,0
	100	30,40	107,42	2,10	**		
37,5	**225**	30,30	99,77	-0,07			
	188	30,37	100,00	Mt		**LSD 5%=**	0,7
	150	31,20	102,73	0,83	*	**LSD 1%=**	1,1
	113	31,67	104,27	1,30	**	**LSD 0,1%=**	1,6
	75	32,57	107,23	2,20	***		

Regarding the influence of sowing density on the grain weight per panicle, for 12.5 cm distance between rows, the variant sown with 200 g.s./m² compared to the control, recorded a difference of 0.08 g. and the value of this is distinct significant positive.

For 25 cm distance between rows, compared to the control, only the variant sown with 100 g.s./m² is statistically assured and is distinct significant positive, and for 37.5 cm distance between rows, the variants sown with 150 g.s./m² and 113 g.s./m² are distinct significant and the variant sown with 75 g.s./m² is very significant, recorded a difference of 0.08 g (*Table 2)*.

Regarding the influence of sowing density on the 1000 grains weight, for 12.5 cm distance between rows, the variant sown with 300 g.s./m² and 200 g.s./m² compared to the control, recorded a difference of 1.11 g. respectively 1.46 g. and are very significant positive.

Table 2

The influence of sowing density on the grain weight per panicle

Distance between rows (cm)	Sowing density g.s./m²	Grain weight/ panicle	% compared to control	Difference	Semnif.		
12,5	**600**	0,68	98,48	-0,01			
	500	0,69	100,00	Mt		**LSD 5%=**	0,05
	400	0,70	100,83	0,01		**LSD 1%=**	0,07
	300	0,73	105,26	0,04		**LSD 0,1%=**	0,11
	200	0,77	111,65	0,08	**		
25	**300**	0,84	98,47	-0,01			
	250	0,85	100,00	Mt		**LSD 5%=**	0,04
	200	0,88	103,06	0,03		**LSD 1%=**	0,06
	150	0,89	104,59	0,04		**LSD 0,1%=**	1,00
	100	0,91	107,29	0,06	**		
37,5	**225**	0,97	99,96	0,00			
	188	0,97	100,00	Mt		**LSD 5%=**	0,02
	150	1,00	102,93	0,03	**	**LSD 1%=**	0,03
	113	1,01	104,47	0,04	**	**LSD 0,1%=**	0,05
	75	1,04	107,44	0,07	***		

For 25 cm distance between rows, compared to the control, all the variants are statistically assured as following: the variant sown with 300 g.s./m² is distinct significant negative, the variants sown with 200 g.s./m² and 150 g.s./m² are distinct significant positive and the variants sown with 100 g.s./m² recorded a difference of 1.58 g. being very significant.

For 37.5 cm distance between rows, the variant sown with 300 g.s./m² is distinct significant negative and all the variants sown with an higher density than that of the control are very significant (*Table 3)*.

Table 3

The influence of sowing density on the 1000 grains weight

Distance between rows (cm)	Sowing density g.s./m²	1000 grains weight	% compared to control	Difference	Semnif.		
12,5	**600**	30,28	98,16	-0,57	o	**DL 5%=**	0,5
	500	30,85	100,00	Mt		**DL 1%=**	0,7
	400	31,30	101,45	0,45		**DL 0,1%=**	1,0
	300	31,96	103,59	1,11	***		
	200	32,31	104,74	1,46	***		
25	**300**	31,39	97,82	-0,70	oo		
	250	32,09	100,00	Mt			
	200	32,74	102,02	0,65	**	**DL 5%=**	0,4
	150	33,08	103,07	0,99	**	**DL 1%=**	0,6
	100	33,67	104,91	1,58	***	**DL 0,1%=**	1,0
37,5	**225**	32,45	98,50	-0,49	oo		
	188	32,94	100,00	Mt			
	150	33,62	102,05	0,68	***	**DL 5%=**	0,2
	113	34,36	104,31	1,42	***	**DL 1%=**	0,4
	75	35,20	106,86	2,26	***	**DL 0,1%=**	0,5

CONCLUSIONS

In 2013, the oat crop had optimal conditions for growing and plant development in terms of climatic and seedbed preparation conditions of the sowing and caring for the culture.

Due to the researches, it has been found that the highest values at all three productivity characters were obtained to the variant with the sowing density of 75 g.s./m² and the distance between the rows of 37.5 cm. It was observed that the values of all three productivity elements are directly proportional with the distance between rows and inversely proportional to the number of germinable seeds sown per square meter.

For a better quality seeds of oat, used for human consumption in therapeutic purposes, it is recommended a distance by at least 25 cm between rows and to reduced the sowing density; even though the obtained yields will be relatively lower, instead the grain quality will be superior.

BIBLIOGRAPHY

1. Armstrong D.G., Finlayson H.J. – *Cereals for ruminants, Proceedings of the cereals*, Home Grown Authoruty, 1992.

2. Buerstmayr, H., Krenn, N., Stephan, U., Grausgruber, H. and Zechner, E. – *Agronomic performance and* quality of oat (*Avena sativa* L.) genotypes of worldwide origin produced under central European growing conditions. Field Crops Res., (101): 341-351, 2007.

3. Ciuculin V. – *Remedii naturiste,* Slatina, 2006.

4. Mogârzan Aglaia, Gavrilă M., Marin Şt. – *Fitotehnie,* Ed. Ion Ionescu bde la Brad, Bucureşti, 2004, pg. 129.

5. Nirmalakumari A., Sellammal R., Thamotharan G., Ezhilarasi T. – *Trait association and path analysis for grain yield in oat in the Western zone of Tamil Nadu,* IJASR, Vol. 3, Issue 2, 2013.

II. CONSERVATION OF BIOLOGICAL DIVERSITY

LICHENS STUDIES IN THE REPUBLIC OF MOLDOVA AND THEIR ECOBIOINDICATION FEATURES

Adam Begu,
University of the Academy of Sciences of Moldova

Abstract. The lichens diversity of the Republic of Moldova has been studied sporadically over the past 75 years. Most of the publications concerned epiphyte species inhabiting natural reserves and forest ecosystems located in the central part of the country. These type of ecosystems cover a rather small part (c.11%) of the territory and are subject to heavy local and trans-boundary anthropogenic impact. Most lichens are extremely sensitive to increased concentrations of SO_2, NO_x and other gases: the damage is reflected in reduced photosynthesis, necrosis and even thallus destruction. Currently, the lichen diversity of the Republic of Moldova comprises 197 species and varieties, of which 23 species are reported nationally for the first time and 40 species are recommended as reliable indicators. The paper presents a Lichens Toxi-tolerance Scale (LTS) towards SO_2 concentration in the air and Air Quality Assessment Scale (AQAS) with 6 gradations, taking into account the specific diversity, abundance and indicator of species toxi-tolerance.

Key words: lichens, ecobioindication, ecosystems.

INTRODUCTION

Short history of lichen studies in the Republic of Moldova. The first scientific information on lichens in the Bessarabia region was published by Vrabie [48], an agriculture engineer working as an assistant to the National Museum of Natural History in Chişinău. He investigated lichen species density within five habitats around Chişinău: the oak forests of Durleşti and Căpriana, plum orchards in Valea Dicescu and near Ghidighici, and *Sophora* sp. trees along the Cricova School Road. He revealed some 200 individuals belonging to 30 lichen species and provided a description of 25 species and 5 varieties, with 3 species remaining unidentified. The purpose of his research was to assess the density and geographical orientation (16 cardinal directions) of lichens on tree trunks. The author concludes that lichen species density is almost uniform on cardinal directions, except the isolated *Sophora* trees, where 7 lichens species had the highest (49.2%) and lowest (24.6%) distribution in diametrically opposite directions – NE and SW. The author explains this difference by the action

of natural factors (humidity, sunlight, wind etc.). Furthermore, the data presented in the tables and figures reveal some aspects of the air quality. The richest lichen diversity was in the Căpriana and Durlesti forests (18 and 15 species, respectively), followed by the habitat at Ghidighici (14 species). The poorest lichens diversity was at Chişinău, Valea Dicescu and Cricova School Road, with 7 species each. The air quality can also be assessed by the presence of species rather sensitive to pollution that cover >10% of trunks: at the Căpriana site – *Evernia prunastri* (16,3%), *Lecidea enteroleuca* (11,1%), *Physcia adscendens* (12,9%), and at the Ghidighici site – *Physcia adscendens* (15,5%). The difference in air quality between the forest habitats and those of Chişinău and Cricova, indicated by the lichens, is obvious.

Scientific investigations on lichen diversity in Moldova were given a boost by the activity of G. Simonov [37, 38, 50], who studied lichen taxonomy, chorology, morpho-anatomical features, environmental groups, preferred habitats etc. Summarizing his activity [37], he confirmed the existence of 124 lichen species (from 50 genera, 7 families and 26 orders) in the Republic of Moldova. *Lecanorales* dominate (97 spp.), with *Lecanora* (12), *Parmelia* (12), *Cladonia* (9), and *Ramalina* (7) being the main genera. The author mentioned the dominance of crustose species (59) as compared to foliose and fruticose (34); xerophytic species (69) against mezophytic (8); and photophile species (64) against sciaphile (8). This underlines the dry climate of recent decades and anthropogenic impact as being the two main factors explaining the poverty of the local lichen diversity. At the same time, Simonov [37] mentioned the richness of the lichen in forest ecosystems (90 species) and petricolous ecosystems (35 species), both dominated by crustose species (43 and 29 species, respectively), followed by those with a foliose thallus (29 and 9 species, respectively). It is well known that epilithic species have a mainly crustose structure and such species are not recommended for ecobio-indication because they remain practically indifferent to pollutants at moderate and high concentrations [32].

Recently, the bio-indicator features of lichens have become a research subject at the National Institute of Ecology. Over 80 meadow and hill forest ecosystems were studied, targeting epiphytic lichen species, and bio-indicator species, in particular. Lichen abundance, toxi-tolerance and diversity were studied, against air quality. The results were presented in a number of works by Begu [5, 6, 7, 8, 9, 10, 11, 12, 13].

Starting in the 1960s, Mîrza & Obuh [30] performed studies on lichen diversity in the forest habitats of Călineşti, Balatina and the scientific reserve "Padurea Domnească", mentioning 58 lichen species, of which 28 were reported for the first time in the country. Colun [17], who studied the lichens within the protected areas in the middle course of the Dniester River, mentioned 14 species, of which 4 were indicated for the first time in the country, and Obuh & Colun [34] indicated 47 species for the middle course of the Prut River, 9 of them for the first time. The contribution

of Vasilenko [47] who identified 21 lichen species in the Mereneşti forest, of which 4 were reported as new for the Republic of Moldova, should also be mentioned.

All these scientific inputs (of which Professor Simonov's must be mentioned first and foremost), have contributed to the lichen register of the Republic of Moldova, which currently encompasses 197 species and varieties, some of which can be used as reliable indicators of air quality.

Assessment of environmental quality through lichen indicator species. The use of bio-indicators started in the second half of the 19th century, and particularly developed as lichen indication [33], which was applied to monitor air pollution, especially sulphur dioxide as well as nitrogen oxides, ozone, fluorine, chlorine etc.

The increased sensitivity of lichens to gases and fumes is explained by their slow regeneration, as compared to higher plants, which can renew damaged tissues rather quickly [23]. Under long-term water deficit, lichens become even more vulnerable to air pollution. Garrou & Castrogiovanni [22] explained lichen sensitivity to sulphur dioxide by the fact that the pollutant is converting chlorophyll into pheophytin, substituting one atom of magnesium with another of hydrogen.

The role of lichens as bio-indicators of air pollution in the Rocky Mountains (USA) was extensively studied by S. Simonson [39]. Mihailova & Vorobeicik [29] studied the dose-effect relationship in lichens in the forests of the Middle Ural region. They found significant changes in lichen synusia even at a slight exceeding of background pollution levels (1.5–2.3 times). Studies in the field were undertaken by researchers of the State University of Tartu (Estonia) leaded by Trass [43, 44, 45, 46], who proposed a list of test species and a 5-grade scale for air quality monitoring. He developed the Poleotoleration Index (IP) for spatial mapping of air pollution with sulphur dioxide. Blium [15] suggested that the elaboration of indication scales should take into consideration the sensitivity of lichens to different air pollutants (SO_2, NH_3, H_2S, CO, petrol vapors) established under laboratory conditions.

The application of lichen criteria in the assessment of air quality and mapping of urban pollution in industrial areas of Romania was considered by several authors [2, 3], [4], [18], [19], [20]; [21]; [31], [40], [41]; [42]. An outstanding research was carried out by Bartók [2], who made an inventory of the lichen diversity of the Zlatna industrial area to determine the influence of pollutants on lichen formations in different ecological niches. Later on, the same author [3] applied a quantitative method of mapping the intensity of air pollution based on lichens substrate coverage, frequency, abundance and tolerance, thus designating areas with different degree of pollution. Ştefănescu & Bartok [41, 42] undertook a joint research on lichen species from the Romanian industrial region of Baia Mare by mapping the intensity of air pollution.

MATERIALS AND METHODS

The placement of lichen species into a systematic classification is as well of importance for theoretical science [35]. The classification system used the following several works [49], [14] and scientific names are used according to Kondratyuk et al. [25].

Currently there is much information on disturbances to the vital activity of lichens caused by atmospheric pollutants [1]; [16]; [36]; [44]; [15]; [29]. This has allowed some authors to specify gradations of SO_2 concentration [24]; [26]; [27]. The concentrations indicated vary greatly between authors, perhaps because some of the data were obtained in the laboratory, whereas others were obtained in field conditions; besides, such aspects as emission structure, climatic conditions, research methodology also differ. Most authors indicate a concentration of sulphur dioxide in the air of 0,05mg/m^3 as the threshold of the clean air zone. The harmful effects start occurring at 0.1–0.3mg/m^3, some indicating the concentrations > 0.3 mg/m^3 as very polluted air and the fatal concentration as being 0.5 mg/m^3.

Performing a large retrospective of phyto- and zoo-indication, Măciucă [28] proposed bio-monitoring as an important alternative to the traditional monitoring of forest ecosystems.

RESULTS AND DISCUSSIONS

Aspects of the use of plants as bio-indicators have not so far been studied in Moldova. The undersigned initiated sporadic studies on lichens indication aspects in the Chiţcani forest (1992), the Potoci forest resort (2001), and Chişinău (2001). In 2001, the laboratory of environmental impact and ecobio-indication was founded at the National Institute of Ecology, with research activities focused on lichen species as bio-indicators. A particular emphasis was put on bio-indicator features of lichens in forest and petricolous ecosystems. The Republic of Moldova Lichens Register was completed with 23 new species (Table 1).

Table 1

Lichen species described for the first time in the Republic of Moldova and ecosystems where the species were identified during the period 2002-2005

Name of species	Name of forest ecosystem
1. Arthonia dispersa (Schrad.) Nyl. (*A. epipasta* Körb. = *A. minutula* Nyl.)	Durleşti, Saharna, Cuhureştii de Sus
2. *Arthonia punctiformis* Ach. (*A. atomaria* Mass., *A. populina* Mass.)	Şoldăneşti, Burlăneşti
3. Buellia lauri-cassiae (Fee) Müll. Arg. (*B. triphragmia* Arn.)	Căpriana, Iabloana, Mândreşti
4. Caloplaca aurantiaca (Lightf.) Th. Fr. (*C. flavorubescens* (Huds.) J.R. Laundov /*Placodium aurantium* Vain.)	Plaiul Fagului

5. Caloplaca elegans Th. Fr.	Plaiul Fagului
6. Candelaria concolor (Dicks.) Stein.	Bălăneşti, Codri, Plaiul Fagului
7. Leptogium saturninum (Dicks.) Nyl.	Bahmut
8. Hypocenomyce scalaris Ach. Ex. Lilj Choisy *(Psora scalaris)*	Plaiul Fagului
9. Parmelia olivacea (L.) Nyl. (*Imbricaria olivacea* DC. *Lichen olivaceus* Hoffm.)	Lopatna, Păpăuţi, Căpriana, Iabloana, Lucăceni, Mândreşti, Şoldăneşti, Curchi, Cobac, Sărata Galbenă, Pogăneşti,
10.Phaeophyscia nigricans (Flk.) Stitzenb	Lopatna, Durleşti, Saharna, Cotul Morii Păpăuţi, Şoldăneşti, Plaiul Fagului
11. Physcia tribacia (Ach.) Nyl.	Teţcani, Pererâta, Tohatin
12. Physcia ciliata (Hoffm.) DRietz (*Ph. obscura* Hampe)	Ciocana, Cărbuna, Congaz, Taraclia, Corneşti, Bahmut
13. Parmeliopsis ambigua (Wulf.) Nyl. (*Parmelia ambigua* Ach.)	Plaiul Fagului
14. Verrucaria fuscella (Turn.) Ach. (*V. areolata* Wallr.)	Lopatna (defileul Jiolnaia)
15. Xanthoria substellaris (Ach.) Vain (*X.fallax* Du Rietz = *X. ulophylla* Arn.)	Cuhureşti, Ciorna, «La Castel»
16. Aspicilia gibbosa	Lopatna
17. Ramalina pulvinata (Arnzi.) Nyl.	Iargara
18.Parmelia pseudolivertorum	Cobac, Sărata Galbenă
19. Parmelia subaurifera	Valea Mare
20. Parmelia subulata	Trebisăuţi
21. Evernia furfuracea (L.) Mann. – *Parmelia furfuracea* (L.) Ach.	Plaiul Fagului, Codri, Căpriana, Trebisăuţi
22. Microthelia atomaria (DC) Korb. – *(M. korberi* Trevis.*)*	Plaiul Fagului, Rubleniţa, Temeleuţi, Păpăuţi
23. Cladonia glauca Flörke	Briceni

By applying the a.m. method we established the presence of 40 lichen species as indicators of air quality: 3 species – with I degree, 16 species – II, 16 species – III, 3 species – IV, 2 species – degree V of toxi-tolerance, which may certainly form the basis of biological monitoring in our country (Table 2). The frequency of these species in forest ecosystems is rather high, which guarantees the use of the same species for the forest sector, but also gives the opportunity to connect to the National and European Ecological Network, as many species are common to the European environment.

Table 2

Lichen species as indicators of air quality

No.	Species	Toxi-tolera-tion
1	*Anaptychia ciliaris* (L.) Koerb. Ex A. Massal	II
2	*Bacidia rubella* Hoffm.) Massal. (*B. luteola* (Schrad.) Mudd.)	II
3	*Candelariella aurella* (Hoffm.) Z. ahlbr.	III
4	*Candelariella vitelina* (Hoffm.) Mull. Arg.	IV
5	*Cladonia fimbriata* (L.) Fr. f. *fimbriata*	II
6	*Cladonia pyxidata* (L.) Hoffm.	II
7	*Evernia prunastri* (L.) Ach.	III
8	*Graphis scripta* (L.) Ach.	II
9	*Hypogymnia physoides* (L.) Nyl.	III
10	*Lecanora carpinea* (L.) Vainio	III
11	*Lecidella elaeochroma* (Ach.) Hertel. (*Lecidea glomerulosa* (DC.) Steud. L. *enteroleuca* Ach. L. *olivacea* (Hoffm.) Massal *Lecidella glomerulosa* Stend.)	III
12	*Lepraria incana* (L.) Ach. (*L. aeruginosa* Sm)	V
13	*Parmelia acetabulum* (Neck.) Duby.	III
14	*Parmelia caperata* (L.) Ach.	II
15	*Parmelia olivacea* (L.) Ach.	III
16	*Parmelia quercina* (Willd.) Vain.	II
17	*Parmelia scortea* f. *scortea* Ach.	III
18	*Parmelia sulcata* Taylor	II
19	*Parmelia verruculifera* Nyl.	III
20	*Peltigera polydactyla* (Neck.) Hoffm. *f. polydactila*	I
21	*Pertusaria discoidea* (Pers.) Malme. (*P. albescens* (Huds.) Choisy & Werner, *P. globulifera*)	II
22	*Phaeophyscia nigricans* (Florke)Moberg (*Physcia nigricans* (Flk.) Stizb.)	IV
23	*Phaeophyscia orbicularis* (Nesk.) Moberg (*Physcia orbicularis* Potsch emend. Du Rietz.), *Ph. virella* (Ach.)	IV
24	*Phlyctis argena* (Spreng.) Flot.	III
25	*Physcia ascendens* (Fr.) H. Oliver.	III
26	*Physcia aipolia* (Ehrh. Ex Humb.) Furnr. Hampe emend. Nyl. var. *aipolia*	II
27	Physcia caesia (Hoffm.) Furnr.	II
28	*Physcia stellaris* (L.) Nyl.	III
29	*Physcia tenella* (Scop.) DC. (*Ph. hispida*)	II
30	*Physconia distorta* (With.) J.R. Laundon (*Ph. pulverulenta* f. *izidiigera)* A.Zahl.	III
31	*Physconia grisea* (Lam.) Poelt (*Physcia grisea* (Lam.) A.Z.)	III
32	*Protoparmeliopsis muralis* (Schreb.) M. Choisy *Placolecanora muralis* (Schreb.) Ras.	II
33	*Pseudevernia furfuracea* (L.) Zopf. (*Evernia furfuracea* Mann.)	II
34	*Ramalina farinacea* (L.) Ach.	II
35	*Ramalina fraxinea* (L.) Ach. var. *fraxinea*	I
36	*Ramalina pollynaria* (Westr.) Ach. var. *pollynaria*	II

37	*Ramalina roesleri* (Hochst. Ex Schaer. Hue)	II
38	*Usnea hirta* (L.) F.C.Weber ex F.H.Wigg.	I
39	*Xanthoria candelaria* (L.) Th. Fr. (*X. ucrainica*)	III
40	*Xanthoria parietina* (L) Th. Fr.var. *parietina*	V

Basing on the analysis of literature, as well as field and laboratory testing of 15 lichen species, we propose a Toxi-tolerance Scale with 6 steps, as shown in Table 2. The presence of lichens as such is not necessarily an indication criterion, as previously stated for higher plants. To have an indicative value lichens must have a certain abundance. In our view, a coverage of 10% of the substrate surface could be a clear indicator. Proceeding from the abundance and toxi-tolerance of the indicators we have elaborated a scale with gradations for the evaluation of air quality (Table 3).

Table 3

Gradations in air quality assessment based on abundance of lichens with different toxitolerance

SO_2 content in the air, mg/m^3	**Air quality**	**Toxitol-eration degree**	**Lichens toxitoleration**	**Abundance of species with different toxitoleration degree, % of substrate surface**
<0,05	Clean	I	Highly sensitive	I > 10 or I < 10 and II > 75
0,05-0,1	Slightly polluted	II	Sensitive	I – 0 -10 or II – 50-75
0,1-0,2	Moderately polluted	III	Moderately resistant	II - 10-50 or III > 50
0,2-0,3	Polluted	IV	Highly resistant	III - 10-50 or IV > 50
0,3-0,5	Heavily polluted	V	Desert zone	IV - 10-50 or V - 1-100
>0,5	Critically polluted	VI	Complete absence of lichens	Complete absence of lichens

CONCLUSIONS

1. The Republic of Moldova Lichens Register has been established, based on a literature review and our own research, which includes about 200 species and varieties (23 noted by the author).

2. The basis of lichens as ecobio-indicators has been established, based on the presence of 40 indicator species sensitive to air pollution by SO_2, NOx etc.

3. Two criteria for the evaluation of the state of environmental components have been proposed: a Lichen Toxi-tolerance Scale (LTS) with 6 levels, taking into account the degree of air pollution by SO_2, the similarity of geographical conditions, and the results of own testing through applying gases, transplanting and studies in the field; and Gradations for Air Quality Assessment (GAQA) in forest and urban ecosystems, based on indicator abundance/coverage, toxi-tolerance and correlation between different bio-indicator species.

BIBLIOGRAPHY

1. Atlas, R. M., Schofield, E. *Respons of the lichens Peltigera aphthosa and Cetraria nivalis and alga Nostoc commune to suplur dioxide, natural gas and crude oil in Artic Alaska*, Astarte. 1975, V. 8, № 2: 35-38.

2. Bartók, K. Influienţa poluării atmosferice asupra florei lichenologice din zona industrială a Zlatnei*, Contrib. bot. Univ. Babeş - Bolyai. Cluj-Napoca*: 1980, 195-199.

3. Bartók, K. Cartarea poluării atmosferice pe baza sensibilităţii lichenilor, *Contrib. bot. Univ. Babeş – Bolyai, Cluj-Napoca*: 1985, 51-57.

4. Bartók, K., Rusu, A.-M., Kozma, A. Caracterizarea gradului de poluare al oraşului Cluj-Napoca prin componentul lichenologic*. Environment and Progress*, 2003, Cluj-Napoca: 29-33.

5. Begu, A. Evaluarea impactului asupra ecosistemelor silvice prin metoda bioindicaţiei, *Buletinul AŞM, Ştiinţe biologice, chimice şi agricole,* 2004, **1**, 292: 156-161.

6. Begu, A. Ecobioindicaţia – metodă eficientă în monitorizarea calităţii mediului, *Mediul Ambiant*, *Revistă ştiinţifică de informaţie şi cultură ecologică. Ediţie specială. Chişinău*: 2005, 45-49.

7. Begu, A. Air pollution monitoring in forest ecosystems using bioindicators. *7th Subregional Meeting on Effect-oriented Activities in the Countries of Eastern and South-eastern Europe*, Baia Mare, România: 2006, 65-78.

8. Begu, A. Aplicarea scalelor bazate pe toxitoleranţa lichenilor în reflectarea calităţii aerului, *Contrib. ştiinţ. în tehnol. şi echipam. pentru eval. şi protecţia mediului.* Simp. Naţ. cu particip. internaţ. Ed. a IV-a. Arcalia: 2008, 24-25.

9. Begu, A., Boguş, S. Unele particularităţi ecologice în răspândirea lichenilor din preajma staţiunii Potoci (jud. Neamţ*) Simp. Jub. cons. aniv. 30 ani a rezerv. „Codrii",* Vol. I, Lozova: 2001, 5-6.

10. Begu, A., Calugareanu, N., Buburuz, D. Aspecte privind elaborarea standardelor ecologice pentru evaluarea ecosistemelor, *Buletinul AŞM, Ştiinţe biol., chim. şi agric.,* 2003, **2,** 291: 134-138.

11. Begu, A., Liogchii, N., Creţu, A. Aspecte privind lichenoflora unor ecosisteme forestiere şi calitatea aerului. *Conferinţa internaţională „Aspecte ştiinţifico-practice a dezvoltării durabile a sectorului forestier din Republica Moldova",* Chişinău 17-18 noiembrie, ICAS: 2006, 150 – 155.

12. Begu, A., Manic, Şt., Şalaru, V., Simonov, Gh. *Ciuperci. Plante fără flori*. Min. Ecologiei şi Resurselor Naturale al Rep. Moldova. Acad. de Şt. a Rep. Moldova. Fondul Ecologic Naţ. – Ch.: Î.E.P. Ştiinţa, (Combinatul Poligr.) – Ser.: „Lumea vegetală a Moldovei", 2005, **I**: 204.

13. Begu, A., Simonov, Gh. Biodiversitatea lichenofitelor evidenţiate în perioada 2001-2005 în ecosistemele naturale ale Republicii Moldova, *Materialele Simpozionului Jubiliar – Rezervaţia „Codrii"- 35 an,* Lozova: 2006, 26-27.

14. Bisby, F.A.,Rugierro, M.A., Wilson, K.L., Cachuela-Palacio, M., Kimani, S.W., Roskov, Y.R., Soulier-Perkins, A., van Hertum, J. *Species 2000 & ITIS Catalogue of life: 2005 Annual Checklist.* CD-ROM; Species 2000: Reading, U.K. 2005.

15. Blium, O. B. Sravnitelinaia oţenca deistvia toxiceskih gazov na CO_2 – gazoobmen lişainicov*, Ecologicesk. i fiziologo-biohim. aspectî antropotoler. rastenii*. Vses. Conf. Tezisî dokl., **I**, Tallin: 1986, 39-41.

16. Burton, M. A. S. Biological monitoring of environmental contaminants (plants), *Monitoring and Assessment Research Centre, King's College London, University of London, MARC Report,* Number 32, 1986.

17. Colun, A. Lichenoflora rezervaţiilor peisagistice „Saharna" şi „Ţipova" şi a rezervaţiei „Prutul de Jos*", Rezumatele lucrărilor. Simpozion Jubiliar consacrat aniversării a 30 ani de la formarea rezervaţiei „Codrii"*, Vol I, Lozova: 2001, 14-15.

18. Cretzoiu, P. *Flora lichenilor folioşi şi fruticuloşi epidendri şi epixili din România*, ICEF, 47, Bucureşti: 1941, 1-72.

19. Crişan, F. Aprecierea comparativă a calităţii mediului în două aglomerări urbane: Bruxelles şi Cluj - Napoca, utilizând ca bioindicatori macrolicheni epifiţi, *Mediul – cercetare, protecţie şi gestiune. Univ. Babeş - Bolyai. Cluj-Napoca*: 2002, 34-35.

20. Crişan, F., Pop, I. Epiphyte foliose lichens-bioindicators of air pollution in the city of Cluj-Napoca, *Beitrage zur Naturwissenschaftlichen Erforschung Seibenbiirgens*, Bohlau Verlag Koln: 1997, 135-143.

21. Cristea, V., Baciu, C., Gafta, D. Municipiul Cluj-Napoca şi zona periurbană: studii ambientale, Ed.: Accent, Cluj-Napoca: 2002, 332.

22. Garrou, E., Castrogiovanni, G. *Indicatori biologici. – Piemonte parchi*, Numero 42. AnnoVI. № 7, ottobre. Spedizione in Abbonamento Postale Gr. IV/70%. II° simestre: 1991, 30-32.

23. Guderian, R. *Zagreaznenie vozduşnoi sredî.* Perevod s angliiscogo N. S. Geliman. Izd-vo Mir, Moskva: 1979, 200.

24. Hawksworth, D. L. and Rose, F. Quantitative scale for estimating sulphur dioxide air pollution in England and Wales using epiphytic lichens, *Nature*, Lond. 227: 1970, 145-148.

25. Kondratyuk, S., Khodosovtsev, A., Zelenko, S. *The second checklist of lichen forming, lichenicolousand allied fungi of Ukraine.* Kiev, Phytosociocentre: 1998, 180.

26. Le Blanc, F. et Rao, D. Effects of sulphur dioxide on lichen and moss transplants. *Ecology*, 54 (3): 1972, 612-617.

27. Liiv, S., Martin, L., Piarn, H., Ăănsaar, A. Sravnenie rezulitatov fitoindicaţii i drugih metodov, ispolizovannîh dlia opredelenia zagriaznennia vozduha v gorodah Ăstonii, *Problemî sovremennoi ăcologii, Ăcologiceskie aspectî ohranî ocrujaiuşcei sredî v Ăstonii.* Tezisî II respubl. Ăcolog. Conf., Tartu: 1982, 50.

28. Măciucă, A. Aspecte privind utilizarea bioindicatoilor în supravegherea ecosistemelor, *Bucovina Forestier*, **XI**, 1. Comentarii. Univ. Ştefan cel Mare. Suceava: 2003, 53-58., email ancam@eed.usv.ro

29. Mihailova, I. N., Vorobeicik, E. L. Ăpifitnîe liheno-sinuzii v usloviah himicescogo zagreaznenia: zavisimosti doza-ăfect, *Ăcologia,* **6**: 1995, 455-460.

30. Mîrza, M., Obuh, P. Lichenoflora din Rezervaţia „Pădurea Domnească", *Buletin ştiinţific al Muzeului Naţional de Etnografie şi Istorie Naturală*, vol. 1(14), Chişinău: 2004, 227-236.

31. Mohan, Gh., Gîrlea, D. Lichenii şi briofitele – indicatori ai gradului de poluare atmosferică, *Studii şi comunicări*, **V**, Muzeul Piteşti. Piteşti: 1980, 21-24.

32. Nilison, Ă. M. Ăcologiceskie osnovî antropotolerantnosti ăpifitnîh lişainicov. *Ecologicesk. i fiziologo-biohim. aspectî antropotoler. rastenii*. Vses. Conf., Tezisî dokl., **I**, Tallin: 1986, 126-127.

33. Nylander, W. Les lichens du Jardin de Luxemburg, *Bul. bot.,* France, 1865, **V**. 13: 364-372.

34. Obuh, P., Colun, A. Diversitatea lichenilor crustacei din zonele protejate ale Prutului mediu, *Biodiversitatea vegetală a Republicii Moldova.* Culegere de articole ştiinţifice. Chişănău. Centrul Editorial al USM: 2001, 149-153.

35. Reivn, P., Ăvert, R., Aikhorn, S. *Sovremennaia botanica*, ***I; II***, Moskva, Iz-vo Mir: 1990, 348; 344.

36. Richardson, D. H. C., Nieboer, E. Surface binding and accumulation of metals in lichens, Cellular interactions in symbiosis and parasitism. *Columbus: Ohio State University Press*: 1980, 75- 94.

37. Simonov, Gh. Lichenofitele din spaţiul teritorial al Republicii Moldova, *Grădina Botanică la 50 de ani / Cartea Moldovei*, Tipografia Universul: 2004, 78-81.

38. Simonov, Gh., Istrati, A., Chirtoacă, V., 1994, Contribuţii floristice în landşaftul natural „Trebujeni", *Congresul I al botaniştilor din Moldova*: 14-15.

39. Simonson, S. *Lichens and Lichen – Feeding Moths (Arctiidae: Lithosiinal) as Bioindicators of Air Pollution in the Rocky Mountain Front Range,* 2003, saras@lamar.colostate.edu. Accesat în martie, 2004.

40. Ştefănescu, G. Micluţa, A., Bartók, K. Zonarea intensităţii poluării atmosferice în bazinul industrial Baia Mare cu ajutorul lichenilor, *Buletin ştiinţific. Seria B*. **IX,**Fascicola: Fizică - Chimie, Biologie. Baia Mare: 1992, 199-205.

41. Ştefănescu, G., Bartók, K. Criterii lichenologice în cartarea intensităţii poluării atmosferice în centre urbane şi bazine industriale, *Buletin ştiinţific. Seria B,* **XIII**. Chimie - Biologie. Univ. de Nord. Baia Mare: 1998, 127-132.

42. Ştefănescu, G., Bartók, K., 1998, Noi date privind cartarea lichenologică a intensităţii poluării atmosferice din bazinul industrial Baia Mare, *Buletin ştiinţific. Seria B*. **XIII**. Chimie - Biologie. Univ. de Nord. Baia Mare: 133-137.

43. Trass, H. *Analiz lihenoflorî Ăstonii*, Avtoref. dis. d-ra nauk. Tartu: 1968, 80.

44. Trass, H. Lişainiki i zagreznenosti vozduha, *Jizni rastenii, **3**, Vodorosli. Lişainiki.* Pod red. Prof. M.M. Golerbaha, M., Prosveşcenie: 1977, 431-433.

45. Trass, H. Lihenoindikaţia kak metod biomonitoringa dinamiki okrujaiuşcei sredî, *Problemî sovremennoi ăcologii, Ăcologiceskie aspectî ohranî ocrujaiuşcei sredî v Ăstonii.* Tezisî II respubl. Ăcolog. Conf., Tartu: 1982, 47-48.

46. Trass, H. Classî poleotolerantnosti lişainicov i ăcologiceskii monitoring, *Problemî ăcologiceskogo monitoringa i modelirovania ăcosistem.*, L.: Gidrometeoizdat: 1984, 144-159.

47. Vasilenko, S. Ăcologiceskie osobennosti lişainicov Mereneştskogo lesa, *Ecologie şi Protecţia Mediului – cercetare, implementare, management.* Mater. Conf. Jubiliare – INECO 15 ani. 29 dec. 2005. Ch.:Institutul Naţional de Ecologie: 2005, 95-98.

48. Vrabie, Gr. Materiale pentru studiul lichenilor din regiunea Chişinăului, *Buletinul Muzeului Naţional de Istorie Naturală din Chişinău.* Redactat de Dr. I. Lepşi. **5**, 1933. Chişinău: Tiparul Moldovenesc: 1934, 88-121.

49. Global Biodiversity. Earth's resourse in the 21st century: 2000, 246.

50. Republica Moldova. Primul Raport Naţional cu privire la diversitatea biologică, Chişinău: 2000, 65.

PROBLEMS OF PROTECTION AND CONSERVATION OF RARE PLANTS IN THE STATE DENDROLOGY PARK «ALEXANDRIA» OF THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE

S.I. Galkin, L.V. Kalashnikova

The State Dendrology Park «Alexandria» of the National Academy of Sciences of Ukraine Bila Tserkva – 13, Kyiv region, 09113 Ukraine

Abstract. The present research deals with problems of protection and conservation of 6 natural and 66 alien species of rare and vanishing plants entered into the Red Book of Ukraine in quasinatural phytocenosis of the State Dendrology Park «Alexandria» of the National Academy of Sciences of Ukraine. Information is given on the state of natural and formed biogroups and alien populations, ecological-coenotic and biological features of species. Perspective rare species are identified for conservation in the Dendrology Park as evaluated by their viability and by the degree of acclimatization.

Key words: rare plants, conservation, red book.

INTRODUCTION

In the second half of the 20th century studies on protection of vegetable species in view of catastrophic impoverishment of the gene pool of the biodiversity acquire the priority value in botanical gardens and dendrology parks and the research work conducted therein is mainly focused on the protection of rare species in the conditions of *ex situ,* rational use, renewal and enrichment of the biotic and landscape diversity. The problem of protection of natural riches, which is basic for the modern approach of humanity to the protection of environment, was formulated at the UN Conference on environmental issues and development in 1992 in Rio de Janeiro, which adopted the International Convention on Biodiversity (CBD) joined by 190 countries [11].

By the present time, no less than 368 species of vascular plants have disappeared on the earth and about 20,000 species need protection [14]. Hence, a number of international documents have been adopted aimed at protection of the biotic of constituent of the environment, namely: Convention on International Trade in Endangered Species CITES [7], Convention on Protection of Wild Fauna and Flora and Natural Habitats in Europe [6], Convention on Biological Diversity [8], Global Strategy of Plant Conservation

(2004) [1], International program of plant protection in botanical gardens (BGCI, 2000) etc. At the latest XVIII International Botanical Congress in 2011 in Melbourne the tasks of Global Strategy for the protection of plant variety to 2020 have been renewed and defining the primary among them as follows: bringing in to the culture of rare and vanishing species and protection of plant communities.

The new release of the supplements to the Convention (1997) [15] included 534 «European» species of plants from 95 genera, including 49 – «Ukrainian», and the Red book of Ukraine (2009) protects 611 species of vascular plants [12]. Nine species from the flora of Ukraine, which totals 4500 species of vascular plants, have disappeared, another 26 species are under the threat of disappearance, yet, already 30% species of the flora of Ukraine are in collections, seminal funds and the tissue culture of botanical gardens and dendrology parks [13]. In 1994, Ukraine, as a member of the UNO, signed the Convention on Biodiversity and today we already have the well enough developed legal base on protection of biodiversity, in particular, there is the special purpose legislation on the natural reserves fund (NRF), animal kingdom, vegetable world etc. Among the state program papers of fundamental value is the program «Reserves» (1994), decrees of the Cabinet of Ministers of Ukraine (CMU) «On improvement of the state administration of the natural reserves network in Ukraine» (1994), «On the Concept of protection of biodiversity of Ukraine» (1997), Law of Ukraine «On the National program of forming the national reserves network of Ukraine for the years 2000-2015» (2000) etc. In accordance with the CMU resolution «On approval of the Concept of the National program of protection of biodiversity» (2000), decrees of President of Ukraine «On measures for further development of the nature protection and reserves network in Ukraine» (2005) and «On additional measures on development of the nature protection and reserves network in Ukraine» (2009) the protection of wild-life on the basis of systematic concern for environmental, economic and social interests of society, as well as international obligations of the state is acknowledged as one of major priorities of the long-term policy of Ukraine. At the current phase, the main documents for the protection of the rare biodiversity are the provisions on the Green Book of Ukraine (2002) and Law of Ukraine «On the Red Book of Ukraine» (2004). In 2009, the Presidential decree ratified the bill about the national special purpose ecological program of development of the natural reserves network to 2020. According to this document, it is planned to develop the long-term scientific program of protection and recreation of rare species of the vegetable and animal world, primarily the endangered ones and entered into the Red Book of Ukraine and are located within the territories and objects of the natural reserves fund. Reduction of the number of species up to their complete disappearance is caused, for one thing, by the anthropogenic factor and destruction of natural coalescence sites. Studies devoted to the protection of rare species in transformed natural phytocenosis are almost non-existent. This kind of research would enable not only to save the rare species but also create them new localities.

The Dendrology Park «Alexandria», with the area 400.67 hectares was founded in 1788 in the town of Bila Tserkva, Kyiv region. The park is located in the north-eastern part of Right-bank Forest-steppe of Ukraine at the height of 80-106 meters above the sea level with the geographical co-ordinates of the latitude 49°48" and the longitude 30°03". The climate in the area is moderate continental, comparatively mild with the average annual temperature of 6.93°C and with fluctuations in separate years from 5.8°C to 8.5°C. The minimum temperature is –32.4°C (January), whereas the maximum +38°C (June). The average precipitation for a long-term period amounts to 498 mm, about 80 % of which is rainfall. The number of days with frosts is 137 (110 – 163), including without thaw – 63 days. The soil temperature of °C and below is observed to the depth 0.4 meter, beginning from December to March. The average annual relative humidity makes 76%. The snow-cover is not permanent, lies on the average for 60 days, with a maximum thickness of 20 cm. In recent years the snow-cover tends to be thinner and the number of days with frosts - fewer. The Park landscapes are created on the basis of the natural oak planting, age of separate oaks reaches 300-350 years. At present they make quasinatural ecosystems which, by their ecological features occupy an intermediate position between natural and cultural ecosystems and, although cannot be classified as natural objects, they actually are the breeding ground of biodiversity on the ecologically impoverished territories [3]. In the landscape terms, they are moderately exploited and close to natural biotopes preserving ecotopes with different ecologic and cyanotic conditions, namely: forest, forest-steppe, steppe, off-shore, that enables to protect a significant number of rare and vanishing species of plants with the European and Eurasian types of natural habitats in the conditions close to natural.

MATERIALS AND METHODS

The purpose of the research is the protection of rare and vanishing species of plants in quasi-natural ecosystems of the Dendrology Park by the method of creation of new loci of artificial (alien) populations which can be self-renewable and do not need permanent intervention from a man, as well as the recreation of natural populations of rare species.

RESULTS AND DISCUSSIONS

According to inventorying in 2012, the collection of rare and vanishing species of plants in the Dendrology Park 'Alexandria' encompasses 72 species, 68 of which are protected by the Red Book of Ukraine, 2 are rare for the Kyiv region: *Matteuccia struthiopteris* (L.) Tod., *Digitalis lanata* Ehrh. and 2 species are protected by other lists of rare plants: *Astrantia major* L., *Sedum boryssovae* Balk. 9 of them are included into the International list of rare plants (the Red Data Book), 9 – to the European list, 6 – to the Supplement to the Bern Convention and CITES. The natural flora of the Dendrology Park has 6 species: *Adonis vernalis* L., *Pulsatilla pratensis* (L.)

Mill., *Pulsatilla grandis* Wender, *Stipa capillata* L., *Galantus nivalis* L., *Matteuccia strutioptheris*, the other 66 species are alien.

Introduction of rare plants began in the XIX century, when five species of rare woody plants: *Larix polonica* Racib., *Taxus baccata* of L., *Syringa josikaea* Jacq., *Staphylea pinnata* of L., *Euonymus nana* Bieb. They were first cultivated as decorative. To the present time there remains one tree of *Larix polonica* the age of which is 175 years. Placing the Dendrology Park under the Academy of Sciences of Ukraine in 1946 increased possibilities of seed exchange with botanical establishments as well as the number of expeditions which resulted in including such species in the program of research: *Chamaecytisus albus* (Hacq.) Rothm., *Ch. podolicus* (Blocki) Klaskova, *Sorbus torminalis* (L.) Crantz, in 1990s, the catalogues of the Dendrology Park already listed 23 species of rare plants [2, 5].

At the beginning of the XXI century the work on the protection of rare plants was enhanced to a new scientific level. Nowadays, the collection includes 17 relics of the tertiary and pleistocene periods: *Taxus baccata*, *Pinus cembra* L., *Fraxinus ornus* L., *Betula humilis* Schrank, *Syringa josikaea*, *Euonymus nana*, *Draba aizoides* L., *Allium lineare* L., *Allium obliquum* L., *Allium strictum* Schrad., *Carex davalliana* Smith, *Ligularia sibirica* Cass., *Delphinium elatum* L., *Dryas octopetala* L., *Atropa belladonna* L., *Staphylea pinnata*, *Tamarix gracilis* Willd.; 9 endemics: *Larix polonica*, *Tulipa quercetorum* Rlokov et Zoz, *Stipa ucrainica* P. Smirn., *Lonicera caerulea* L., *Cerastium biebersteinii* DC., *Chamaecytisus podolicus*, *Aquilegia transsilvanica* Schur, *Cerasus klokovii* Sobko, *Spiraea polonica* Blocki; 9 species that are relics and purely local endemics simultaneously: *Asphodeline lutea* (L.) Rchb., *Achillea glaberrima* Klokov, *Betula klokovii* Zaverucha, *Lunaria rediviva* L., *Campanula carpatica* Jacq., *Cephalaria litvinovii* Bobrov, *Crataegus pojarkovae* Kos., *Daphne Sophia* Kalen., *Daphne taurica* Kotov; 25 borderline areal species (near the border of the natural habitat): *Galanthus nivalis*, *Leucojum vernum* L., *Eremurus spectabilis* Bieb., *Crocus angustifolius* Weston, *Crocus heuffelianus* Herb., *Crocus reticulatus* Steven ex Adams, *Gladiolus umbricatus* L., *Iris furcata* Bieb., *Iris sibirica* L., *Tulipa biflora* Pall., *Aster alpinus* L., *Leontopodium alpinum* L., *Biscutella laevigata* L., *Chamaecytisus albus*, *Chamaecytisus rochelii* (Wierzb.) Rothm., *Genistella sagittalis* (L.) Gams, *Trifolium rubens* L., *Dracocephalum ruyschiana* L., *Glaucium flavum* Crantz, *Aquilegia nigricans* Baumg., *Pulsatilla grandis*, *Pulsatilla pratensis*, *Rhamnus tinctoria* Waldst. et Kit., *Dictamnus albus* L. *Sorbus torminalis*. That is, the species with the natural habitats limited by their area and with narrow specialized ecological niches make up 89% in the collection. In line with the last edition of IUCN (Red List Categories, 1994) the listed species belong to the categories with the status «critically endangered» (CR), «endangered» (EN) and «vulnerable» (VR). The species in the collection: *Dianthus gratianopolitanus* Vill. has the status of «extinct from the wildlife» (EW); *Lilium martagon* L., *Stipa pennata* L., *Stipa tirsa* L., *Dianthus pseudoserotinus* Blocki, *Paeonia tenuifolia* L., *Scopolia carniolica* Jacq., *Daphne*

cneorum L. – «low rate danger» (LR), and *Allium ursinum* L., *Stipa capillata* L., *Stipa lessingiana* Trin. et Rupr., *Adonis vernalis* L. – «data deficient» (DD). In biogroups (as biopreservatives), natural and alien populations 37 species of plants are already saved in the ecotopes of the Dendrology Park, 35 are going through introduction tests in the collection area. As for their representability, only 8 species are widespread in 3 – 6 coalescence sites of the Dendrology Park.

Concerning the type of biomorph the collections represent: trees – 7 species, bushes – 14, bushlets – 2, semibushes – 4, redivives – 45, among them 7 species – ephemeroids and hemiephemeroids. The spectrum of life-forms is represented by 21 phanerophytes, 12 chamaephytes, 26 cryptophytes, 13 geophytes. As for geoelements, the largest group is made up of Eurasian unmorals – 24 species; European petrophilous – 13, holarctic European boreal – 10, Eurasian mountain – 10, Mediterranean and Eurasian steppe – 11, Mediterranean unmoral – 5, European off-shore – 3 species. The analysis of ecobiomorphes showed that the sun-loving faction – 60 species – prevails among heliomorphes, among hygromorphes most are mesophytes – 27 species, xeromesophytes – 19 and mesoxerophytes – 13, xerophytes – 9, hygromesophytes – 8, hygrophytes – 2. That is, the typical representative of the collection is a sun-loving mesoeutrophyc mesoxerophyte.

At the present phase, in order to research the degree of adaptation as well as acclimatization and selection of the most viable in the ecological conditions of the Dendrology Park rare and vanishing species of plants, we are studying the biological and ecological features of the species included in the collection. Based on the data of the conducted research we traced the phenological phases and gave estimation of the term of completion of growth of one-year sprouts, the duration of the vegetation period and the state of plants after wintering. For most of the probed species the duration of vegetation made up 186+7 – 226+2 days, all of them within the vegetation period of the local climate (216 days). Most species wintered without the damages of sprouts of the past vegetation and had Grade I (by the VIII-grade scale of resistance to the cold) and only *Tamarix gracilis* and *Atropa belladonna* had Grade II (insignificant damages of sprouts of the past vegetation). In recent years (2010, 2011) the winters were of anomalous character, in February the average monthly temperature indexes were 7.2°C below the long-term average, that resulted in the damage of plants of such species: *Chamaecytisus albus, C. podolicus, Crataegus pojarkovae* (Grades II-III – the ends of sprouts of the past vegetation are frozen at full length); *Tamarix gracilis*, *Leontopodium alpinum*, *Dianthus pseudoserotinus* (Grade VI – frozen to the level of snow-cover). Late spring light frosts, also recorded in 2010-2011, negatively affected flowering of the probed plants, the duration of which for 61 species ranges from 15 to 40 days, beginning in March-April for species with the early spring period of flowering: *Galanthus nivalis*, *Leucojum vernum*, *Crocus angustifolius*, *C. heuffelianus*, *C. reticulatus, Pulsatilla grandis, P. pratensis*, *Adonis vernalis* and concluding the summer-autumn (repeated) flowering for *Dryas octopetala*, *Daphne*

cneorum, *D. sophia*, *D. taurica*, *Euonymus nana*, which lasts from the first ten-day periods of July to the end of September. The biological intensity of flowering depends on the air temperature and humidity, precipitations, wind, pollinators, and made up, according to the five-grade scale with 46 species – 1 and 2 grades (50-75% sprouts of the proper age flower), 11 – 3 grades (smaller part of sprouts flower) and 5 species – 5 grades (single sprouts flower).

The first flowering which is an essential index of the degree of acclimatization of the given species for woody plants was recorded with *Dryas octopetala* at the two-year age; *Chamaecytisus albus*, *C. podolicus*, *Genistella sagittalis*, *Daphne cneorum*, *D. sophia*, *D. taurica*, *Euonymus nana*, *Tamarix gracilis* – three-year; *Betula humilis*, *Fraxinus ornus*, *Cerasus klokovii, Spiraea polonica* – at the four-year. *Syringa josikaea* and *Chamaecytisus rochelii* effloresced during the fifth year, and *Staphylea pinnata* – during the sixth. The analysis of phenological spectrums of flowering showed that they were resistant for most species, which proves the introduction successful.

Plants of 56 species of the collection (78%) produce seed: among them – 31 species abundantly and satisfactorily, and form self-seeding annually, and the other 25 species produce seed irregularly or in small quantities and rarely – self-seeding.

45 plant species (63%) are able for vegetative reproduction. 12 species of long rhizomatous plants are marked for active spontaneous vegetative reproduction: *Matteuccia struthiopteris, Allium ursinum*, *Carex davalliana*, *Euonymus nana*, *Staphylea pinnata*, *Cephalaria litvinovii*, as well as species of the *Stipa* group and also species of root-proliferous plants: *Chamaecytisus podolicus*, *Cerasus klokovii*, *Daphne sophia*, which in the conditions of introduction form brush. 33 species of plants display nonintensive vegetative reproduction, this is typical of most bulbous plants, namely: *Galanthus nivalis*, *Leucojum vernum*, species of the *Crocus*, *Tulipa quercetorum* and others. 25 species of the probed plants (36%) do not reproduce vegetatively.

The research shows that rare species of the broad-leaved forests and steppes (50 species in the collection) are perspective by their degree of adaptation and acclimatization for protection and forming of biogroups and alien populations in quasi-natural phytocoenosis of the Dendrology Park.

By their viability [10] and the highest acclimatization rate [9], the most perspective rare and vanishing species of woody plants in the conditions of the Dendrology Park, which reproduce in the seminal and vegetative way, are considered the following 11 species: *Taxus baccata, Larix polonica, Cerasus klokovii, Chamaecytisus podolicus, Genistella sagittalis, Fraxinus ornus, Euonymus nana, Sorbus torminalis, Staphylea pinnata, Syringa josikaea, Spiraea polonica*. Another 6 species are estimated as perspective which acclimatized well: *Chamaecytisus albus, C. rochelii, Daphne cneorum, D. sophia, D. taurica, Dryas octopetala.* Four species: *Pinus cembra*, *Betula klokovii*, *Crataequs pojarkovae*, *Rhamnus tinctoria,* the young plants of which did not reach reproductive maturity, are also fully perspective for conservation in the conditions of the Dendrology Park, and the degree of their acclimatization at

the present time is considered satisfactory. *Tamarix of gracilis* is estimated as less prospective due to unsteady indexes of resistance to the cold.

Many botanical institutions in Ukraine have gained extensive experience in creating populations of rare plants as parts of model and artificially made groupments allowing opportunities for the conservation of the gene pool of rare species. In the conditions of "Alexandria" Dendrology Park, an important issue remains the expansion of the experience of introduction on the basis of locally reproduced plants and forming their introduction populations allowing the transmission of target properties and features to the next generations of plants. Such species, as *Taxus baccata, Staphylea pinnata*, *Euonymus nana* have been fully naturalized in the phytocenosis of the Dendrology Park and form the homoeostatic, balanced, normal type alien populations with the area of 650 m², 2,900 m² and 140 m², capable of long-term existence under insignificant anthropogenic pressure. *Syringa josikaea*, *Spiraea polonica, Fraxinus ornus, Rhamnus tinctoria, Chamaecytisus podolicus, Genistella sagittalis, Sorbus torminalis, Cerastium biebersteinii* have acclimatized well and are preserved as biopreservatives in the alien biogroups. Gradually, depending on the biomorph of the species and the most favorable ecological conditions, in quasinatural ecosystems of the Dendrology Park, we form alien populations of *Cerasus klokovii*, *Daphne sophia*, *Cephalaria litvinovii, Allium ursinum, Dianthus gratianopolitanus, Aquilegia nigricans, A. transsilvanica*.

The state and quantity of individuals in the natural populations of *Matteuccia struthiopteris*, *Galantus nivalis*, *Stipa capillata* constantly change. The population of *Stipa capillata* occupies the area of 1,200 m² amounting to 100 genesic individuals. There are plants of all age groups (from seed to the senile individuals), mature, normal type.

At present, the population of *Galantus nivalis* is regressive, unsteady, low-density – up to 10 individuals per 1 m², with prevailing genesic individuals. The population of *Matteuccia struthiopteris* occupies the area of 900 m² and includes 200 genesic individuals, in the recent years its area has diminished almost twice, whereas the number of individuals has decreased by several times as a result of change of the climatic conditions and due to the anthropogenic factor. However, so far the natural populations of these species have been assessed as homoeostatic. Our further research will be focused on their recreation and permanent ecological and demographic local monitoring.

Another important issue of the protection of plants is cultivation of environmental awareness among people. For the purpose of ecological education, in recent years tourist popular science and educational programs have been created, the most popular of which are ecological paths. The latter, including the ecological paths of the Dendrology Park «Alexandria» are aimed at boosting ecological culture and behavior of man in his inter-relations with nature, increasing his awareness of the signs of anthropogenic influence and its effect on the environment. Hence, the

main requirements we set for development of the route of an ecological path in the Dendrology Park are to show the unique combination of valuable natural complexes with the rare, vanishing species of plants and animals and historical objects, as well as to ensure availability, informativity, satisfaction of the visitors' cognitive needs on historical, geographical, biological and ecological issues.

CONCLUSIONS

Thus, the method of reproduction of natural, as well as formation of alien plant communities of rare and vanishing species combines approaches to plant conservation *ex situ* and *in situ*: availability of the proper ecological niche; conditions ensuring the vital necessities of the species; a high coefficient of vegetative reproduction; ability of self-seeding; availability of the proper biological links, etc. The ecocenotic conditions of the Dendrology Park «Alexandria» are favourable for conducting such work due to its area, as well as the style and age of its planting.

BIBLIOGRAPHY

1. *The Global Strategy of Plant Conservation*. – Moscow: Department of the International Council of Botanical Gardens for Plant Conservation, 2004. – 16 p.

2. Deriy I.G. *The Dendroflora of «Aleksandriya» Dendrology Park of the Botanical Garden of the Academy of Sciences of Ukraine* – Kyiv: Publishing House of the Academy of Sciences of Ukraine , 1958. – p. 110-132.

3. Dubrovskiy Yu.V. *Quasinatural Ecosystems and Their Environmental Significance*. – Belgorod: IPC «Politerra», 2008. – p. 65.

4. *Catalogue of Plants of Dendrology Park «Alexandria»* [edited by L.P. Mordatenko. – Bila Tserkva, 1997. – 100 p.

5. Convention on Protection of Wild Fauna and Flora and Natural Habitats in Europe (Bern,1979) – Kyiv: Ministry of Ecological Safety of Ukraine, 1998. – 76 p.

6. Convention on International Trade in Endangered Species (Washington, 1973). – Kyiv: Ministry of Ecological Resources of Ukraine, 2000. – 80 p.

7. *Convention on Biological Diversity*. – Kyiv: Vik, 2003. – 24 p.

8. Kokhno N.A., Kurdyuk A.M. *Theoretical Basics and Experience of Introduction of Arboreal Plants in Ukraine*. – Kyiv: Naukova Dumka, 1994. – 185 p.

9. Lapin P.I., Sidneva S.V. *Perspective Evaluation of Arboreal Plants Based on Visual Observation*. – Moscow: Nauka, 1973. – pp. 7-67.

10. *Action Programme. Agenda for the 21st Century and other documents of the Conference in Rio-de-Janeiro in popular interpretation*. Geneva: Center for our common future, 1993 – 70 p.

11. *Red Book of Ukraine. Vegetable Kingdom* [edited by Ya.P. Didukha]. – Kyiv: Globalconsulting, 2009. – 900 p.

12. Cherevchenko T.M., Kosenko I.S., Vernyuk G.A. *The Task of Botanical Gardens and Dendrology Parks of Ukraine on Implementation of the Global Strategy of Plant Conservation*. – Dnipropetrovsk, 2005. – pp. 54-57.

13. *Les plants en danger*. – Niestle: Delachaux, 1980. – P. 4-14.

14. Walter K.S., Gillett H.Y. [eds.]. *1997 IUCN Red list of Threatened Plants. Compiled by the World Conservation Monitoring Centre*. – IUCN – The World Conservation Union, G land, Switzerland and Cambridge, 1998. – 862 p.

RENATURALIZATION OF THE CALCIFIED GRASSLAND TERRAINS IN REPUBLIC OF MOLDOVA

Ştefan Lazu, Aliona Miron, Ludmila Talmaci

Botanical Garden (Institute) of the Academy of Science of Moldova
18, Pădurii str., Chişinău, MD-2002, Republic of Moldova

Abstract. This paper presents an analysis of two calcified grassland terrains that were renaturalized. Ground waters are shallow (0.5-2 m), with a type of calcium hydrogen carbonate with solid residue of 0.33 g/l in the meadow of the river Valea Crucii (Botanical Garden (I) of A.S.M.) and 0.96 g/l in the meadow of river Bâc (town Străşeni). The chemical composition of the ground waters influences and determines the floristic and phytocenotic composition of the analyzed grassland, where was registered phytocenosys of ass. Arrhenatheretum elatius (Br. Bl. 1919) Scher. 1925, Soo 1969; Poetum pratensis Răv Cazac et Turenschi 1956; Phragmitetum communis (Gams 1927) Shmal 1939; Agrostetum stoloniferae Soo 1941; Caricetum ripariae Knapp et Stoffers 1962.

Kew words: renaturalization, degraded grassland, calcified grassland.

INTRODUCTION

Renaturalization of the degraded ecosystems represents a procedure of the ecologic reconstruction of the habitat of wild plants and animal species by natural ways that lasts until the achievement of a dynamic equilibrium with main climate factors (temperature and precipitations), and in the case of non-zonal ecosystems like meadow grassland – type of mineralization of ground waters (calcified or sodium).

Renaturalization of the ecosystems is successfully achieved in such countries as England, Germany, and Italy. As a result of that process have been rehabilitated natural forests that allow restoration of the environmental conditions, water quality improvement, increased diversity of flora and fauna, increased ecosystems productivity.

MATERIALS AND METHODS

In Republic of Moldova natural vegetation with grassland meadow was preserved on little area, but the degraded and destabilized one, mostly by overgrazing, constitute most of the meadow terrains. Numerous grassland meadow terrains have been cleared through grubbing, creation of lakes and hydro-ameliorative activities, but habitat conditions are still preserved.

Degraded grassland has little productivity and a floristic and phytocenotic composition inadequate to the soil and climate conditions of the resort.

When completely excluding anthropogenic influence on areas of degraded grassland flora, phytocenotic restoration occurs in ecosystems by forming a dynamic balance with main environmental factors (humidity, temperature, trophicity, the chemical reaction of the soil, groundwater salinization type).

Renaturalization of degraded grassland ecosystems sectors (annual Moldovan cadastre records such surfaces around 3-4 thousand hectares that are categorized as pasture land) is the objective of restoring relations for coexistence of all these ingredients naturally as well as between the latter and the environment.

RESULTS AND DISCUSSIONS

Grubbing meadow land, lowering of groundwater levels, straightening and deepening the river bed in Moldova (years 1960-1980) led to the destabilization of meadow ecosystems, flood disturbance regime, river pollution, accumulation of salts in the soil. Degradation of the natural landscape leads inevitably to the deterioration of human life and decrease of the number of species of flora and fauna gene pool.

Two sectors were analyzed where meadow vegetation was almost completely destroyed and restored by providing absolute protection regime that favored the formation of plant communities' typical meadow ecosystems (Braun-Blanquet J., 1933 Del. Lazu. Et al. 2012).

Sector 1. The river meadow Valea Crucii (right tributary of the river Bic) on the territory of present Botanical Garden (I) of ASM during years 60-70 of the last century was set up a cascade of four lakes, the construction of which totally have damaged primary grassland vegetation and a large part of the soil on which they grew. Currently this grassland vegetation is restored almost entirely, represented by plant communities and floristic composition phytocoenotic suitable to soil and climate conditions of the calcified habitat.

The results of chemical analyzes of groundwater collected in the river meadow Valea Crucii are presented in the literature (Overcenco A et al .., 2008). As mentioned by the authors, the samples were taken in May 2007 from the well N 249 which is in the area "Village Museum" Botanica district of Chisinau or after fence of the Botanic Garden and motorway (gates of the city – the airport). The water depth is 7 m, the residue fix – 0,33 g / l, hardness – 0,66, the concentration of anions HCO_3^{-1} – 83,4%, SO_4^{-2} – 11,6%, Cl^{-1} – 5,0%, NO_3 – 0,1%. Cations concentration is: Ca^{+2} – 48,0%, Mg^{+2} – 28,5%, Na^{+1} and K^{+1} – 23,5%. Groundwater chemical composition of such type is calcium hydrogen carbonate. Lakes of Botanical Garden are a few hundred meters downstream of the well N 249 from which samples were taken for chemical analysis.

Groundwaters in the meadow are at a variable depth - 0.5-5 m. Depending on its depth in the soil were formed various herbs communities with calcium habitat.

Ass. *Phragmitetum communis* (Gams 1927) Shmale 1939).

Mesohygrophyte and hydrophilic conditions where groundwater is shallow (0.5 m) phytocenosis with reed grows from association *Phragmitetum communis* (Fig. 1). These communities form belts on the perimeter of ponds 1-4 and a larger area of about 0.5 ha in the meadow upstream of Lake 4. Communities of reed are common in swamps sectors with groundwater with carbohydrates, calcium and magnesium. Dominant species – reed has a height of 2-3 m and 4-5 with uniform dispersion abundance. Sporadically, are presented the species: *Equisetum palustre, E. ramosissimum*, *Carex riparia, C. otrubae, C. vulpina*, *Alopecurus geniculatus, A. pratensis*, *Bidens tripartita*, *Glyceria plicata*, *Calystegia sepium, Humulus lupulus, Lysimachia nummularia, Lythrum salicaria, Myosoton aquaticum, Plantago major, Polygonum aviculare, Ranunculus acris, Solanum dulcamara, Tussilago farfara, Typha angustifolia, T. latifolia, Lycopus europaeus, Catabrosa aquatica, Poa palustris, Galium palustre.*

Fig. 1. Grassland meadow renaturalized by *Phragmites australis.*

Fig. 2. Meadow renaturalized with *Poa pratensis* (Botanic Garden, 20/05/2013).

Ass. *Poetum pratensis* Răv. Cazac et Turenschi 1956

Phytocoenoses with meadowgrass are present in the meadow of the river Valea Crucii near the Northeast of Lake № 1, mezohygrophyte habitat, mesotrophic, groundwater is 0.5-1.0 m deep. Meadowgrass abundance-dominance prevail 3-4, evenly distributed over the surface of the grassland (fig. 2).

Out of typical plant species have been noticed: *Festuca pratensis* with a reduced abundance and *Alopecurus pratensis*. Has been observed the presence of other 13 plants species: *Lysimachia nummularia, Melilotus officinalis, Potentilla reptans, Ranunculus repens, Taraxacum officinalis, Trifolium repens, T. pratense, Lamium purpureum, Plantago major, Rumex confertus, Daucus carota, Dactylis glomerata.*

It is clear that this meadow sector has not yet reached perfection in phytocenotic formation and the balance between Prato-formation species with essential components

and habitat conditions are still ongoing. Phytocenosis of this association have a productivity of 40-50 kt / ha of a high forage value.

Ass. *Arrhenatheretum elatioris* (Br. Bl. 1919 s. l) Schererer 1925, Soo 1969

Phytocoenosis with oatgrass (*Arrhenatherum elatius*) is met in the meadow of river in Botanical Garden's large areas of the northern lawn in the vicinity of the lakes No. 2 and 3. They grow on fertile soils, mesophilic, where groundwater is the type calcium and magnesium carbohydrates and is at a depth greater than 1 m. Abundance of oat-grass – 4-5, 100% coverage. In the floristic composition of grasslands renaturalized with oat-grass, was also confirmed the presence of the following species: *Dactylis glomerata, Bromus arvensis, Carex vulpina, Lathyrus pratensis, L. tuberosus, Erigeron canadensis, Plantango lanceolata, Agrimonia eupatoria, Poa pratensis, Rumex acetosa, Trifolium pratense, T. repens, Armoracia rusticana, Cardaria draba, Convolvulus arvensis, Sonchus arvensis, Verbascum austriacum, Chamomilla recutita, Taraxacum officinale, Daucus carota, Achillea millefolium, Lotus corniculatus, Medicago romanica, Alopecurus pratensis, Ranunculus reptans, Juncus gerardii, Tragopogon dubius.*

Oatgrass meadows have a height of 1.2-1.5 m (Fig. 3) and ensure elevated productivity, which varies within 50-60 q / ha dry matter of high forage value.

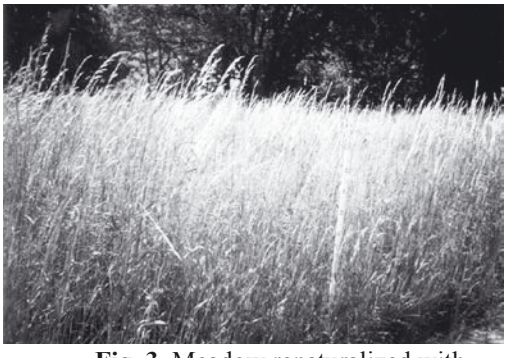


Fig. 3. Meadow renaturalized with *Arrhenatherum elatius* (Botanical Garden, 15.06.2005)

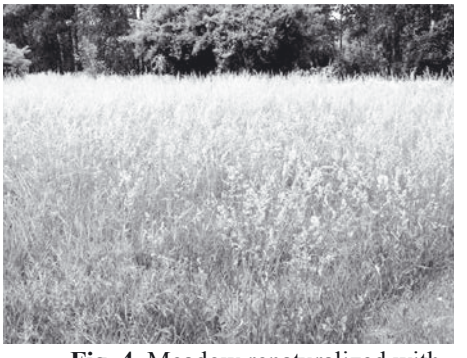


Fig. 4. Meadow renaturalized with *Dactylis glomerata* (Botanical Garden, 22/05/2013**)**

Phytocenosis with domination of orchard grass (*Dactylis glomerata*)

Meadow renaturalized with orchard grass is present on the right bank of the river on lawn near the lake 2 near the footbridge separating lakes 2 and 3. Grass coverage is 60-80%. Abundance of orchard grass – 2-3. Grass height – 70-80 cm. In the meadow were observed the following species of vascular plants: *Poa pratensis, Lolium perenne, Elytrigia repens, Elytrigia intermedia, Phragmites australis, Arrhenatherum elatius, Bromus arvensis, Poa pratensis, Carex vulpina, C. riparia, C. melanostachya, Trifolium pratense, T. repens, Lathyrus tuberosus, Symphytum officinale, Rorippa*

austriaca, Plantago lanceolata, P. media, Chelidonium majus, Arctium tomentosum, Artemisia vulgaris, Achillea setacea, Agrimonia eupatoria, Anthriscus sylvestis, Erigeron canadensis, Euphorbia salicifolia, Galium aparine, Geum urbanum, Glechoma hederacea, Leonurus cardiaca, Melandrium album, Taraxacum officinale, Verbascum phlomoides, Veronica austriaca, Saponaria oficinalis, Vicia dumetorum, Viola alba, Tragopogon dubius, Ranunculus reptans, Potentilla reptans, Medicago falcata, Melilotus officinalis, Lamium purpureum, Lysimachia nummularia şi altele. Meadow productivity is about 40-50 kt/ha of high quality hay.

Sector 2. Renaturalized meadow in the Marshy meadow to calcium habitat on the right River Bic. Bic River floodplain meadows (town Străşeni) are grazed excessively during the season, reaching a deep state of degradation and decline in productivity and forage value.

As is mentioned by Шекун Г. М. (1987) citing the journal „Бессарабское сельское хозяйство" (1905), meadow grassland on Bâc river (commune Străşeni) at the beginning of the XX century had a high yield of 500 pounds of hay per "desetine" or 80 q/ha. It emphasizes the high quality of these forages.

In the meadow of river Bâc (town Străşeni), the "Association of hunters and fishermen" (year 2002) have taken under protection 22.22 ha meadow terrains on the right side of the river, where have been carried out the following activities: stop grazing, land weirs with water drainage and restoration of floodplain inundation regime of the river, and applying an effective system of protection.

The sector is on the medium part of floodplain of the river Bic and includes (according to cadastre data) 16.28 ha of grassland vegetation of mezohygrophyl grasses, 5.19 ha marshy meadow and 0.75 ha mesophyte meadow. Today the entire area of 22.22 ha is under fluid regime where water still flooded due to weirs but the water is flowing.

According to the chemical analysis data of alluvial groundwater in the meadow of r. Bâc (Bucovăţ village, d. Străşeni) have a dry residue of 0,96 g/l, hardness – 2,14 with domination of calcium hydrogen carbonate and the presence of anions – HCO_3^{-1} – 74,4%; SO_4^{-2} – 5,1%; Cl^{-1} – 20,4%; NO_3^{-1} – 0,1% and cations – Mg^{+2} – 22,9%; Ca^{+2} – 59,7%; $Na^{+1} + K^{+1}$ – 17,4% (Overcenco A. et., 2008).

Flora and vegetation of the meadows is at the stage of major transformation from mesophilic regime at mezohygro- or hygrophile. Up to time of forming actual flooded water regime were spreading herbaceous formations of ass. *Agrostetum stoloniferae* Soo 41, which main essential characteristics are spread in the near vicinity (*Ranunculus repens*, *R. acris*, *Potentilla arenaria*, *P. reptans*, *Agrostis stolonifera*, *Carex cespitosa*, *C. otrubae*, *Eleocharis palustris*). Mesophilic meadow flora and vegetation is preserved on the area of 0.75 ha meadow near Bic river bed. Here are recorded floristic components of ass. *Agrostetum stoloniferae* with subass. *Equisetum pratense* and characteristic species: *Geranium pratense*, *Equisetum pratense*, *E.*

arvense, *Lysimachia nummularia*, *Galium mollugo* ş. a.). Near the Bic river is attested the presence of solitary willow trees (*Salix cinerea*, *S. caprea*).

On the rest of the protected floodplain area of the river Bic are found communities of hydrophilic grasses in cl. *Phragmito-Magnocaricetea* Klika 1941; with association *Typhetum angustifolio-latifoliae* (Essl. 1933) Schmale 1939; *Scirpo-Phragmitetum* W. Koch 1926; *Caricetum acutiformis-riparia* Soó (1927) 1930; *Caricetum vulpinae* Soó 1927; *Eleocharicetum palustris* Senicov 1919.

CONCLUSIONS

Current land meadows in Moldova represent mostly degraded pastures with forage mass productivity between 3-4 ct/ha, reduced floristic composition and phytocenotic organization deviated from normality of soil and climate conditions.

Renaturalising of calcified degraded meadows by optimizing the grazing regime or stopping it and by using them as hay would boost the productivity and enhance the forage mass and its nutritive value and rehabilitation of all ecological parameters of the ecosystem.

BIBLIOGRAPHY

1. Lazu Şt. ş. a. *Pajiştile de luncă cu habitat sodic din Republica Moldova*. Rev. Bot., vol. IV, nr. 1, Chişinău, 2012, p. 36-48.
2. Lazu Şt. ş.a. *Pajiştile de luncă cu habitat calcicol din Republica Moldova*. Conservarea diversităţii plantelor: materiale de simp. şt. inter. 16-19 mai 2012. Chişinău – Iaşi, 2012, p. 253-261.
3. Overcenco A. ş. a. *Resursele acvatice ale Republicii Moldova*. Fântâni şi izvoare: (Atlas ecologic). Chişinău, Ştiinţa. 2008, p. 207.
4. Шекун Г.М. *Использование пойменных земель в кормопроизводстве*. Кишинев, 1987, с. 291.
5. Braun-Blanquet J. *Prodrom des graupements vegetaus*. Montpellier, 1933.
6. Postolache Gh. *Expoziţia Vegetaţia Moldovei din Grădina Botanică a A.Ş.M.* Ştiinţa, 2010, 78 p.

CONTRIBUTION TO THE STUDY OF PLANT COMMUNITIES DOMINATED BY AGROPYRO PECTINATUM – STIPA CAPILLATAE FROM THE REPUBLIC OF MOLDOVA

Ghenadie Titica

Botanical Garden (Institute) of the Academy of Science of Moldova
18, Pădurii, str. Chişinău, MD-2002, Republic of Moldova

Abstract. In this paper, it is proposed to analyze the structure, ecology and syntaxonomy of the communities dominated by *Agropyro pectinati – Stipa capillatae* (Burduja et al. 1956) Chifu et al. 1998, in the semidesert steppes of Moldova. This study has been achieved during our research on communities of plants, conducted in 2007-2012. A number of 15 vegetation relevés have been carried out according to the Braun-Blanquet's methodology, in the spontaneous communities of *Agropyro pectinati – Stipa capillatae*. The results are then analysed in systematic and economical groups, bioforms, floristic elements and ecological indices.

Key words: xerophile vegetation, semidesert steppes, Festuco-Brometea.

INTRODUCTION

Communities *Agropyro pectinati – Stipa capillatae* from the semidesert steppes is located the southern Moldova, in the territory of two districts: Vulcăneşti and Cahul. Steppe species were the most stable and important component of the flora of the slopes (15-37% of the species represented the class *Festuco-Brometea*).

MATERIALS AND METHODS

Phytocoenoses of *Agropyro pectinati – Stipa capillatae* were investigated in the southern Moldova, during our recent field works on years 2007-2012. The present study is based on 15 vegetation relevés. Phytosociological surveys were conducted according to the classical methodology of the Zürich-Montpellier school (Braun-Blanquet, 1964).

RESULTS AND DISCUSSIONS

The ecology and phytocoenological characterisation. Phytocoenoses of *Agropyro pectinati – Stipa capillatae* consisting of *Agropyron pectinatum* and *Stipa*

capilata, are spread in any pastures in the investigated area, creating compact islands of various sizes. Also, due to the intensive depasturage, a secondary association was installed *Festuca valesiaca*. Relevant surveys were found around localities: Giurgiuleşti, Câşliţa Prut, Văleni, Slobozia Mare (Cahul), Etulia (Vulcăneşti), Ciumai (Taraclia). *Agropyron pectinatum* and *Stipa capilata* grow on arid lands and moderate inclination hills. Since stationary conditions in the investigated area not so varied, a poor floristic composition of 43 species was observed. **The spectrum of the bioformes –** the hemicryptophytes are clearly dominant 53.48%, followed by the therophytes with 25.58%, terophytes biennial 11.62%, geophytes and chamaephytes 4.65% each. **The analysis of the phytogeographic elements:** Eurasiatic element 46.51% and pontic species 25.58%, followed by the European and central –European 9.30%, Mediterranean and cosmopolite with 4.65% each. **The analysis of the ecologic spectra:** xeromesophytes species 63%, the xerophytes 34.8%. **The thermic factor** is predominated by temperate-thermophile and microtherm 41.86% each, thermophile 11.62% and 4.65% represented microterms species. According to **soil reaction,** the most of species are slightly acid-neutrophilious 62.8%, acid-neutrophilious 21%, amphytolerant 9.30%, neutrobasiphile 4.65% and acidophile is represented by one species. **Trophic soil reaction** is represented by oligotrophic 16.27%. The most numerous, ensured with nutritive elements, are the plants of very poorly supplied N1 – 9.30%, poor soil N2 – 6.97% and medium soil N3 is represented by 4.65%. **The economical importance of plants**. The analysis of plants from wild flora is represented by four categories of economical importance of plants. The most numerous are the medicinal – 11.62%, alimentary – 4.65%, melliferous and decorative by one species.

CONCLUSIONS

The floristic composition of the communities *Agropyro pectinati – Stipa capillatae* is represented by vegetal communities of semidesert steppes, fact that confirms that the dominant species are *Agropyron pectinatum* and *Stipa capilata*, class Festuco-Brometea. The base for pasture in the investigated area is useful depasturage. Due to the intensive deapasturage, the association has a low forage value, mostly degraded and replaced with the phytocoenosis from the association *Taraxaco serotinae – Botriochloa ischaemum,* also having forage value. The association *Agropyro pectinati – Stipa capillatae* gives 35% of coverage and this factor is influenced by the natural station conditions, altitude, humidity of soil. The analysis of the presence of communities of *Agropyro pectinati–Stipa capillatae* conducted by the researchers allowed them to identify the most valuable objects which should be subject to protection.

Table 1

As. *Agropyro pectinati – Stipa capillatae* (Burduja et al. 1956) Chifu et al. 1998 Syn.: *Stipa capillatae* Burduja et al. 1956 (art. 2b); *Stipetum capillatae* Bârcă 1973(art. 34); *Stipetum capillatae* sensu auct. (art. 36)

Nr.	Importanţa economică	Bioforma	Elementul floristic	Categorii ecologice						Numărul releveului	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	K	ADm
				Halofitia	Scara de azot	U	T	R	Troficitatea	Suprafaţa (mp)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		
										Acoperirea (%)	90	80	80	80	90	90	80	90	80	90	90	90	90	80	80		
1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28
										Car. de as.																	
1		H.	Eua.		N1-2	1	5	3	oligotr.	Stipa capillata	4	4	3	3	3	4	3	3	4	4	3	3	3	4	3	V	47,5
2		H.	Eua.			2	4	4,5		Agropyron pectinatum	+		+		+	+		+		+				+	+	III	0,26
										Festucion valesiacae																	
3		H.	Pt.			1	5	5	oligotr.	Salvia nutans		+			+		+		+		+	+		+		III	0,23
4		H.	Pt.			2	4	4,5		Taraxacum serotinum			+		+	+											I	0,1
5		H.	Pt.			2	3,5	4		Salvia austriaca					+		+	+		+	+		+				II	0,2
6		T.	Pt.			2,5	4	4,5		Ajuga chia		+		+		+	+		+		+	+			+	III	0,26
7		Th.	Pt.			2	4	4		Verbascum speciosum		+			+		+	+		+		+		+		III	0,23
8		T.	Med.			1,5	5	4		Valerianella coronata			+		+		+		+	+		+	+			III	0,23
9		T.	Pt.			2	4	3	oligotr.	Xeranthemum annuum		+		+					+	+				+		II	0,16
10		H.	Pt.			1,5	4	4		Tanacetum millefolium					+	+	+			+	+					II	0,16
11	med. alim.	H.	Eua.		N3-4	2	3	4		Artemisia absinthium				+		+	+									I	0,1
12		H.	Pt.			2	3,5	4		Jurinea calcarea	+		+		+			+			+				+	II	0,2
										Artemision – Kochion																	
13		Ch.	Eua.			1,5	4	4,5		Kochia prostrata		+			+						+				+	II	0,13
14		Th.	Eua.			1,5	4	4		Brassica elongata		+			+		+									I	0,1
										Onopordion Acanthii																	
15		H.	Eua.			2	3	3	mezotr.	Euphorbia esula	+				+			+			+		+			II	0,16
16		H.	Pt.			2	4,5	4,5		Marrubium praecox			+			+			+	+		+				II	0,16
17		T.	Ec.			2,5	3,5	4		Torilis arvensis	+			+			+			+		+		+		II	0,2
18	mel.	H.	Eua.		N3-4	1	4	4		Marrubium vulgare		+			+		+									I	0,1
19	med. mel. alim.	H.	Eua.			2	3	3		Echinops sphaerocephalus		+			+			+			+				+	II	0,16
										Festucetalia valesiacae																	

20	med. mel.	Ch.	Eua.		N1	2	4	4,5		Artemisia austriaca		+			+			+			+			+		II	0,16
21		H.	Pt.			2	4	4,5		Galium humifusum				+			+									+	I	0,1
22	alim.	G.	Ec.			1,5	3,5	4	oligotr.	Allium sphaerocephalon		+					+					+		+		II	0,13
23		T.	Eua.			1,5	3,5	3		Veronica praecox		+						+					+				I	0,1
24		H.	Eua.			1,5	3	4	oligotr.	Ranunculus pedatus			+				+			+			+	+		II	0,16
25		H.	Eua.		N1-2	1,5	3,5	4		Poa bulbosa		+							+			+			+	II	0,13
26		Th.	Eua.			0	0	4		Buglossoides sibthorpiana				+					+					+		I	0,1
27	med. mel.	T.	Eua.		N1	1,5	3	4		Erysimum diffusum		+		+			+									I	0,1
28		H.	Eua.			2,5	3	4		Bromopsis riparia								+			+		+		I	0,1
										Festuco-Brometea																	
29		H.	Eua.		N2	2	3	5		Medicago falcata		+		+					+					+	II	0,13
30		H.	Eua.		N2	2	4	2		Potentilla argentea				+			+			+	+			+		II	0,16
31		H.	Cosm.	hal.		2	3,5	0		Cynodon dactylon		+					+					+				I	0,1
32		T.	sMed.		N2	1,5	4	4	oligotr.	Medicago minima		+			+			+	+					+		II	0,16
33		H.	Ec.			2,5	4	3		Salvia nemorosa		+					+				+					I	0,1
34		T.	Cosm.			2,5	0	0		Erodium cicutarium				+					+		+					I	0,1
35		T.	Cp.			2,5	5	0		Arenaria serpyllifolia		+			+			+					+			II	0,13
36		H.	E.			2	3	3		Achillea collina			+						+			+				I	0,1
37		H.	Eua.			1,5	3,5	4	oligotr.	Linum austriacum		+						+			+					I	0,1
										Diverse																	
38	decor.	G.	Pt.			2	5	3,5		Asparagus tenuifolius		+			+		+									I	0,1
39		Th.	Ec.			2	3,5	4,5		Centaurea pseudomaculosa				+									+		+	I	0,1
40	med.	T.	Eua.			1	3,5	4		Centaurium pulchellum			+						+		+					I	0,1
41		H.	Eua.	hal.		2	4	3		Lepidium perfoliatum		+					+							+		I	0,1
42		T.	Med.			2	4,5	4		Hyoscyamus albus					+									+		I	0,1
43	alim. mel.	Th.	Adv.			2	4	0		Oenothera biennis		+			+						+					I	0,1

Locul şi data efectuării releveurilor:
1, 2, 3 - s. Văleni, s. Vadul lui Isac, s. Colibaşi, r. Cahul, lat : 45.604921° long 28.168608°, 12.06.2009;
4- s. Slobozia Mare, r. Cahul, lat : 45.555957° long 28.163449°, 19.05.2009;
5, 6, 7 - s. Câşliţa Prut, s. Brînza, r. Cahul, lat : 45.528500° long 28.170523°, 07.06.2009;
8 - s. Giurgiuleşti, r. Cahul, lat : 45.502439° long 28.174733°, 01.06.2009;
9 - s. Ciumai, r. Taraclia, lat : 45.794180° long 28.533277°, 29.06.2010;
10,11,12,13,- s. Etulia, r. Vulcăneşti, lat : 45.543582° long 28.449849°, 24.06.2010;
14,15 - s. Alexandru Ioan– Cuza, s. Cişmichioi, r. Vulcăneşti, lat : 45.589203° long 28.452196°, 20.07.2010.

BIBLIOGRAPHY

1. Borza A., Boscaiu N., 1965 – Introducere în studiul covorului vegetal, Edit. Acad. Române, Bucureşti.

2. Chifu T., Minzu C., Zamfirescu O., 2006 – Flora şi vegetaţia Moldovei (România). II. Vegetaţia, Edit. Universităţii „Alexandru Ioan Cuza", Iaşi.

3. Cristea V., 2004 – Fitosociologie, Edit. Presa Univ. Clujeană, Cluj-Napoca.

4. Postolache Gh. Vegetaţia Republicii Moldova, Chişinău, Ştiinţa, 1995. 340 pag.

5. Tofan Burac T., Chifu T., 2002 – Flora şi vegetaţia din valea Prutului, Edit. Corson, Iaşi.

6. Săvulescu Tr. Die Vegetation von Bessarabien mit Besonder Beruckcsichtigung der Steppe. Buc. 1927.

7. Doniţă N., Popescu A., Paucă Comănescu Mihaela, Mihăilescu Simona, Biriş I. – A., Habitatele din România, Editura Tehnică, Bucureşti, 2005.

8. Постолаке Г.Г. Растительность степей Республики Молдова. // Известия АН РМ. Серия биол. и хим. наук. 1993, № 4, с. 3-10.

9. Ciocârlan V., 2009 – Flora ilustrată a României. Pteridophyta et Spermatophyta (Illustrated Flora of Romania. Pteridophyta et Spermatophyta). 2nd Ed., Edit. Ceres, Bucureşti, 1141 pp.

10. Weber H.E., J. Moravec, J.P. Theurillat, 2000 – International Code of Phytosociological Nomenclature. 3rd Ed., J. Veg. Sci., 11: 739-768.

III. INTRODUCTION OF PLANTS AND SUSTAINABLE USE OF PLANT RESOURCES

HISTORICAL INTRODUCTION AND ANALYTICAL ASPECTS OF TAXONOMIC COMPOSITION OF THE GENUS *TAXUS* L. IN THE BOTANICAL INSTITUTIONS OF UKRAINE

Natalia Boiko

The State Dendrology Park «Alexandria» of the National Academy of Sciences of Ukraine Bila Tserkva – 13, Kyiv region, 09113 Ukraine

Abstract. There are historical facts about introduction of species *Taxus* L. in European countries, in U.S., in Russia and Ukraine. The inventory and certain taxonomic composition of trees of *Taxus genus* in botanical institutions of Ukraine. Based on a comparative analysis, it was found that one of the largest collections of species and cultivars of *Taxus genus* is represented in dendropark "Olexandria" of NAS of Ukraine − 3 species, 1 hybrid and 18 cultivars. The prospects of introduction of further work were studied.

Key words: introduction, taxonimic composition, taxus.

INTRODUCTION

The introduction of plants plays significant role in decision of questions about optimization of environment and rational using of natural resources. It is known that thanks to introduction multiplies the number of species of local flora and expand the areas with cultures of ornamental plants, including species of genus *Taxus* L.

In the Ancient Ages the plant introduction was carried out spontaneously and slowly. Accelerated development of the introduction and botanical science on the whole began only in XV century, in the Renaissance epoch. It was connected mainly with numerous geographical discoveries.

The first botanical gardens in Europe were created in the middle of XVI century (in 1540 – Padua; in 1545 – Pisa; in 1560 – Zurich; in 1568 – Florence and Bologna; in 1577 – Leiden; in 1579 – Leipzig). In 1852 Henry Sargent founded the first arboretum [18].

The aim of research: to process historical information about introduction of

species and cultivars of the genus *Taxus*., to take inventory and analyze the taxonomic composition of the genus *Taxus* and to find out perspectives of enrichment of species of *Taxus* in Ukraine.

MATERIALS AND METHODS

Work carried out in period from 2005 to 2013 by handling specialized literature, catalogs woody plants of various botanical institutions and survey collection territories on unprotected soil in National botanic garden of M.M. Grishko of National academy of sciences of Ukraine, Botanic garden of acad. O. Fomin of Kyiv National university of T.G. Shevchenko, Botanical garden of the National University of life and environmental sciences, dendrological park "Olexandria" of NAS of Ukraine, National dendrological park "Sofiyivka" of NAS of Ukraine, dendrological park "Trostianets" of NAS of Ukraine and Krementz Botanical Garden. The objects of studies were a collection of plants of the genus *Taxus*.

RESULTS AND DISCUSSIONS

Plants of genus *Taxus* namely *Taxus baccata* L. were used in parks and private residences in the Antiquity, firstly – in Ancient Greece, then – in Ancient Rome for creation of compositions of cut yew. But, the beginning of active introduction of yew is XVII century. In that time trees of yew were planted in large quantity in gardens, parks, near cemeteries and monasteries of Great Britain, Ireland, Scotland and then spread to other countries of West Europe. It is known that plants of *Taxus baccata* are in one of the masterpieces of landscape architecture – the Palace of Versailles [1].

At the middle of XVIII century, rich landlords of the states: Pennsylvania and Virginia of the USA planted also *Taxus baccata* among other plants.

In the United States and European countries, except a known species *Taxus baccata* and other species of genus *Taxus* were used for decorative horticulture too.

In Europe *Taxus brevifolia* Nutt. was introduced in 1854 [4].

Taxus canadensis Marsh. was cultivated in the countries of Western Europe and the United States in 1900 [4].

Taxus chinensis Rehd. was found in parks of Great Britain and the USA in 1908 [4].

Taxus cuspidata Sieb. Et Zucc. was introduced in Europe during 1854-1856, but in the eastern states of the USA – in 1862 [19, 34].

At present we have no data about the using of other species of genus *Taxus* (*Taxus floridana* Champ., *Taxus globosa* Schlecht., *Taxus wallichiana* Zucc.) for a decorative horticulture.

A study of historical materials about the introduction of cultivars of genus *Taxus* showed that cultivars arose spontaneously in natural populations. So, the cultivar

Taxus baccata 'Fastigiata' (two examples) was found in mountains of Ireland in 1780, then one of them gave a posterity, which spread world-wide [22]. But, the majority of cultivars were selected artificially from seedlings, which were reproduced by seeds in the special nursery. The cultivar *Taxus baccata* 'Dovastoniana' appeared in the own nursery of Jonn Dovaston in Great Britain. The cultivar *Taxus baccata* 'Adpressa' was selected in the Dixon's own nursery of Chester at 1838 [22, 35].

In 1900 Th. D. Hatfield firstly began to grow the yews in the private nursery of the Hunnewell's residence in Massachusets of the USA on the Atlantic Coast. He multiplied *Taxus cuspidata* and its cultivars by vegetative means. Firstly these plants got to the United States from Japan (the native land) owing to the American missionary Dr. George R. Hall of Warren, who brought them in 1862 and sold to the private nursery of the Hunnewell's. Such cultivars as: *Taxus cuspidata* 'Nana', *Taxus cuspidata* 'Densa' and *Taxus cuspidata* 'Capitata' had a big demand [34].

In 1904 the gardener Th. Hatfield began the experiments for seed multiplication of yews, but in 1928 was published his work, where he described the origin of two hybrids − *Taxus* x *media* Rehd. (hybrid of *Taxus baccata* x *Taxus cuspidata*) and *Taxus x hunneweliana* Rehd. (hybrid of *Taxus cuspidata* x *Taxus canadensis*). It has been shown that the hybridization between species was realized spontaneously [37].

At the same time, only in other nursery, the gardener Henry Hick also planted the yews. He is known as a man, who popularized the yews in the gardens and the parks of the USA. He believed that yews are the best plants for landscape gardening and described some compositions with their participation in the Dane Arboretum, the Glen Cove and the Long Island. In 1924, in the "Hicks Nursery Catalog" was published an information about the origin of the cultivar *Taxus* x *media* 'Hicksii' for seeds, which was collected in the Dane Arboretum in 1902. Long time this cultivar was the favorite of the landscape architects between other conifer species and widely spread in the world [34, 38].

The spreading of hybrids was uneven, so *Taxus* x *media* is widely spread in the world and has more 200 cultivars, but *Taxus* x *hunneweliana* is insufficiently spread in culture, there are known only two it's cultivars, which are found in gardens and parks mainly on territory of the USA.

Now the botanical gardens and the parks of the world have in one's collections five species of genus *Taxus*: *Taxus baccata*, *Taxus brevifolia*, *Taxus canadensis*, *Taxus chinensis*, *Taxus cuspidata* and two hybrids – *Taxus* x *media* and *Taxus* x *hunneweliana*. In botanical gardens, parks and towns of the world there are more than 400 cultivars of this genus. Collections of genus *Taxus* are in the botanical gardens and arboretums of the Great Britain, Poland, Germany, Netherlands, Romania, the Czech Republic, Slovakia, Austria, Hungary, Republic Croatia, Italy and many other countries of Europe. A numerous collection of yew is in the Brooklyn Botanic Garden, in the Morton Arboretum and the National Arboretum of the United States [22, 33, 35, 39].

On the territory of former the USSR only two species: *Taxus baccata* and *Taxus cuspidata* are spread in nature [3, 4, 17, 23, 25].

Taxus cuspidata is one of the most long-lived conifer plants in Russia. Its age can be 3000 years. Some tens of trees of the Far-eastern yew grow on the Petrov's Island in Japan Sea. They are witnesses of prosperity of epoch of the Great Golden Empire of the Chzurchzen's (1115-1234), who occupied the territory of Manchuria, the southern part of Far East, part of Northern Korea and the majority of the territory of Northern China. According to people's legends, trees of yew were planted by people of the Petrov's Island about thousands years ago and their planting symbolized the written appeal to descendants. One of hieroglyph was read as the word "a tree" [3, 4].

The beginning of introduction of conifer exotic plants in Russia dates 1706, at that time the Russian Tsar Peter I founded the Summer Garden in Saint – Petersburg [1, 17]. The architect B. Dubyago in own notes wrote that trees of *Taxus baccata* for planting were brought in the Summer Garden from Netherlands [5].

In the Catalog of the Saint-Petersburg Botanical Garden (now the Botanical Garden of the Komarov Botanical Institute) *Taxus baccata* was written in 1736. About successful introduction and acclimatization of yew in Saint – Petersburg indicates that fact that seeds of *Taxus baccata* were offered for exchange between others plants in the List of Seeds of the Botanical Garden of the BIN at 1872 [30].

The works of Regel' contain the information about a presence of second species of this genus in the collection of the Botanical Garden of the BIN, namely *Taxus canadensis*.

Data of Regel' and Kesselring showed that *Taxus baccata*, *T. canadensis, T. brevifolia* were found between 34 species and 64 cultivars of conifer woody species in the nursery for the plant acclimatization of the Saint-Petersburg Pomological Garden at 1911. E. Vol'f in own work (1915) indicated that four species of genus *Taxus* (*T. baccata*, *T. canadensis, T. brevifolia, T.cuspidata*) grew in the collection of the Botanical Garden of the BIN [2, 29].

The literary data indicate that four species of genus *Taxus*, one hybrid (*T.* x *media*) and fifteen cultivars grow in the main botanical organizations of Russia at present [1, 24, 30].

The literary data state that four species: *Taxus baccata*, *Taxus canadensis, Taxus cuspidata, Taxus wallichiana* Zucc., one hybrid (*T.* x *media*) and ten cultivars of genus *Taxus* are in collections of botanical organizations of Belarus [32].

The introduction of woody plants in Ukraine has thousand-year history – from times the Trypillian Cucuteni to present time [18, 19, 25].

In the Carpathian Mountains, Prykarpattia, Transcarpathia, on Bukovina and the Crimean Mountains of Ukraine only one species of genus *Taxus* – *Taxus baccata* is naturally spread [23, 25].

Taxus baccata began to be used in decorative horticulture of Ukraine from the end of XVIII century. In 1760-1770 on a territory of monastery's garden (now the territory of the Botanical Garden of the I. Franko Lviv National University, which was founded at 1852) were planted specimens of *Taxus baccata*, which were preserved until now [15, 31].

The botanical gardens of Ukraine were created according to the European traditions. They appeared at universities in XIX century. The first university was founded at 1804 in Kharkov V.M. Karazin – the first rector of the University set up the first botanical garden in Ukraine. One year earlier, his brother I.M. Karazin founded a park in the small village Osnovy'antzi (now Krasnokhutsk) of the Kharkov province, where were carried 30 species of conifer plants including specimens of *Taxus baccata* [7, 14].

In 1806 professor V. Besser founded the Krementz Botanical Garden. It is known that from the middle of XX century the Krementz Botanical Garden was the first and sole site of successful introduction of *Taxus chinensis* in Ukraine, but in 2006 by our expedition investigations wasn't found any specimen of this species.

This species is absent in the Catalogue of the Kremenets Botanical Garden [7, 20, 21, 23].

In 1812 on the Southern Coast of the Crimea was founded the Nikitsky Botanical Garden, where grow secular specimens of *Taxus baccata*, which are naturally spread in the Crimean Mountains. There is also the large collection of cultivars of *Taxus baccata* in the Garden. It is known that *Taxus cuspidata* several times was introduced in the collection of the Nikitsky Botanical Garden from 1850 [6].

At 1837 in the village Sofiyivka of the Konstyantinograd district of the Poltava province (now the Kharkov region) M. Zarudny creates the private botanical garden, where during 1837-1843 grew *Taxus baccata* [18, 19].

In 1839 the professor R. Trautffeter founded the Botanical Garden of the University of Saint Vladimir (today the Botanical Garden of the Taras Shevchenko National University of Kyiv), which became one of the most rich for quantity of species of plants among botanical collections of Ukraine and all the Russian Empire. Now on its territory still grow secular trees of *Taxus baccata*, which were planted in 1885 [7, 11, 19].

In 1877 the professor Tangl' founded the Botanical Garden of the Chernovtsy University where were planted trees of *Taxus baccata*, which still grow there [15, 19, 25].

In 1893 the doctor Ustinovich creates the Ustimivsky Dendropark (the Poltava region), where he planted clumps of *Taxus baccata*, some specimens preserved to our times [18, 19].

From the beginning of XX century until now *Taxus baccata* is found in collections

of majority of botanical gardens, dendrological parks, arboretums and is also used in landscape gardening of towns of Ukraine.

In Ukraine *Taxus cuspidata* is known in culture from XX century. The oldest specimen of this species grows since 1875 on the territory of the Siretsky Dendrological Park of Kyiv [12]. This species is present in collections of main botanical gardens and dendroparks of Ukraine.

Taxus canadensis is cultivated in Ukraine from XX century. It is a little current species, which firstly was introduced by the M.M. Grishko Botanical Garden in 1959 [7, 9, 11, 20].

The hybrid *Taxus* x *media* was firstly introduced in Ukraine by the M.M. Grishko Botanical Garden from 1975 [7, 9, 20].

In the collection of the "Olexandria" Dendrological Park the genus *Taxus* was from the end of XIX century. So, *Taxus baccata* and cultivar *Taxus baccata* 'Fastigiata' were in the "List of trees and shrubs, introduced in the garden of Count Branitsky near Kiev in 1899". Its age was about 20-30 years [16, 27, 28]. The groups of *Taxus baccata* and two specimens *Taxus baccata* 'Erecta' were planted in the central historic part of the "Olexandria" Dendropark during 1935-1956.

Data of a stocktaking of woody plants of the "Olexandria" Dendropark, which was carried out in 1985, shown that *Taxus baccata* grew in quartels: No. 5, 1, 7, 52, 71, 72. But cultivar *Taxus baccata* 'Aurea' (of planting 1962) in the quartels № 71 wasn't preserved.

At present the composition of the collection of genus *Taxus* of the "Olexandria" Dendrological Park is such: three species – *Taxus baccata*, *Taxus cuspidata*, *Taxus canadensis* and one hybrid *Taxus x media* [13].

Data about species composition of collections of genus *Taxus* in botanical organizations of Ukraine are shown in the table 1.

Having analyzed the species composition of collection of genus *Taxus* in the sixty-three botanical institutions from seven districts of introduction of Ukraine, we found that in the vast majority of them this genus is represented only by one species – *Taxus baccata. Taxus cuspidata* fixed in eighteen botanical institutions, *Taxus canadensis* – in eight and *Taxus* x *media* – in three botanical institutions. The largest collections of species of genus *Taxus* are placed in the M.M. Grishko National Botanic Garden of Kyiv – three species and one hybrid; in the "Olexandria" dendrological Park (of NAS of Ukraine) of Bila Tserkva of the Kyiv region – three species and one hybrid.

In Botanical garden of acad. O. Fomin, Botanical garden of Lviv National university of Ivan Franco, Bilche-Zolotetsk park, in Donetsk botanical garden, in dendrological park of Biosphere reserve "Askania Nova" and Nikitsky botanical garden are growing 3 species of genus of *Taxus*; in Zaporozhye city children's

Table 1

The species composition of the genus Taxus in Ukraine

No.	Name of botanical organization	Taxus baccata	Taxus cuspidata	Taxus canadensis	Taxus x media
	The Carpathian region of introduction				
1.	The Botanical Garden of the Uzhhorod National University	+			
	Prykarpatsky region of introduction				
2.	The Botanical Garden of Chernovtsy National University named Y. Fed'kovich	+			
3.	The Botanical Garden of Prykarpatsky National University named V. Stefanik	+			
	Western region of introduction				
4.	The Botanical Garden of Lviv National University named I. Franco	+	+	+	
5.	The Botanical Garden of Lviv National Forestry University	+	+		
6.	The Botanical Garden of the department of farmakognoziï and botany Lviv National University medical named D. Galizkiij	+			
7.	Stryiskyi Park – a monument of landscape architecture	+			
8.	Obroshynskyy dendrological park of Lviv region	+			
9.	Dendrological park Berezne forest college Rivne region	+			
10.	The Botanical Garden of Volyn National University named L. Ukrainka "Volyn", Lutsk	+			
11.	The Botanical Garden of Khmelnitsky National University	+			
12.	Krementz Botanical Garden	+			
13.	Dendrarium Ternopil National pedagogical University named V. Hnatiuk	+			
14.	Khorostkiv dendrological park of Ternopil region	+	+		
15.	Kamenets-Podilsky Botanical Garden of the SATU	+	+		
16.	Myn'kovets'ky dendrological park of Khmelnitsky region	+			
17.	Otrokivskyy dendrological park of Khmelnitsky region	+			
18.	Bilche-Zolotetskyy Park Ternopil region	+	+	+	

19.	Rayivskyy Park Ternopil region	+			
20.	Hermakivskyy dendrological park of Ternopil region	+	+		
21.	Surazkyy dendrological park of Ternopil region	+			
22.	Belokrinitskaya dendrological park of Ternopil region	+			
23.	Rivne decorative park named T. Shevchenko	+			
24.	Shatskyi Dendrarium forest college of Volyn region	+			
Northeastern region of introduction					
Pravoberezhniy subdistrict of introduction					
25.	The Botanical Garden of Vinnitsa National Agricultural University	+			
26.	The Botanical Garden Zhitomir National Agroecological University	+			
27.	M.M. Gryshko National Botanic Garden	+	+	+	+
28.	O.V. Fomin Botanical Garden of T. Shevchenko Kyiv National University	+	+	+	
29.	Syretskiy dendrological park	+	+		
30.	The Botanical Garden National University of Life and Environmental Sciences of Ukraine	+	+		
31.	Dendrological Park “Yunatskyy” National ecological center	+			
32.	The park − a monument of landscape architecture “Youth” Kyiv region	+			
33.	The Dendrological Park,“Olexandria,” Bila Tserkva	+	+	+	+
34.	The National Dendrological Park “Sofiyivka”, Uman’	+	+		
35.	The Botanical Garden Cherkassy National University named B. Khmelnitsky	+			
Livoberezhniy subdistrict of introduction					
36.	The Dendrological Park ”Trostianets”	+	+		
37.	The Botanical Garden − agrobiostation Nijinsky, “University named N. Gogol”	+			
38.	The Botanical Garden of Sumy State Pedagogical University named after A. Makarenko	+			
39.	The Botanic Garden KhNU named V. Karazin	+			
40.	The Dendrological Park “Krasnokutskiy” Kharkiv region	+			
41.	The Dendrological Park KhNAU named V. Dokuczaev	+			
42.	The Experimental station herbs Berezotocha Poltava region	+			
43.	The Botanical Gardens Poltava National Pedagogical University named V. Korolenko	+			

44.	The Dendrological Park «Ustymivsky» Poltava region	+	+		
The central region of introduction					
Pravoberezhniy subdistrict of introduction					
45.	Forestry the experimental farm "Park Funny Bokovenky" Kirovograd region	+	+		
Livoberezhniy subdistrict of introduction					
46.	The Botanical Garden of Dnipropetrovs'k National University named O. Gonchar	+			
47.	Kriviy Rig Botanical Garden	+			
Donetsk subdistrict of introduction					
48.	Donetsk Botanical Garden	+	+	+	
The Steppe region of introduction					
49.	Zaporozhye City Children's Botanical Garden	+	+		+
Primorsky region of introduction					
Steppenwolf subdistrict of introduction					
50.	The Dendrological Park Biosphere Reserve "Askania New" named F.F. Pfalz-Fein UAAN Kherson region	+	+	+	
51.	The State Enterprise experimental farm "Novokahovskoe"	+			
52.	The Botanical Garden Odessa National University named I. Mechnikov	+			
53.	The Botanical Garden Taurida National University named V. Vernadsky	+			
Subdistrict South coast of Crimea					
54.	The Dendropark House of Nature Sevastopol City of Ukrainian Society for Nature Conservation	+			
55.	Nikitsky Botanical Garden – National Scientific Centre (NBG-NSC)	+	+	+	
56.	The Alupka Park – a monument of landscape architecture	+			
57.	The Gurzufsky Park – a monument of landscape architecture	+			
58.	The Park of the International children Center "Artek"	+			
59.	The Livadia Park – a monument of landscape architecture	+			
60.	Massandrovskiy Park – a monument of landscape architecture	+			
61.	The Park – a monument of landscape architecture in the Utios	+			
62.	Foroskyi Park – a monument of landscape architecture	+			
63.	Harakskyy Park – a monument of landscape architecture	+			

Botanical garden are growing 2 species and 1 hybrid of genus of *Taxus*. In collections of many other botanical organizations of Ukraine, which aren't represented in the table 1.1 and also in the town parks grows mainly only one species of genus *Taxus* – *Taxus baccata* [6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 20, 21, 31].

The largest collection of cultivars of genus of *Taxus* in Ukraine is in the Nikitsky botanical garden. This amounts to 22 cultivars.

In the dendrological park "Olexandria", was created the second collection by number of cultivars in Ukraine and the largest in the Forest-Steppe zone (Northeast district of introduction, Right-Bank Forest-Steppe zone) – 18 cultivars.

In collection of Botanic garden of acad. O. Fomin are growing 10 cultivars, in collection of National botanical garden of M.M. Grishko – 7 cultivars and in National dendrological park "Sofiyivka" are growing 5 cultivars.

In botanical gardens of Lviv National Forestry University and Khmelnitsky National university (Western district of introduction) are collected by 3 and 4 cultivars of genus *Taxus*.

In Zaporozhye city children's Botanical garden (Steppe district of introduction) are growing 5 cultivars, in dendrological park of Biosphere reserve "Askania Nova" (Primorsky district of introduction) – 3 cultivars of genus *Taxus*. Composition of cultivars of *Taxus* in other botanical institutions does not exceed for 1-2.

Having investigated the species composition of the genus *Taxus* in collections of botanical institutions of Russia and Belarus, we found that, in the cultural flora of Ukraine, are absent *Taxus brevifolia* (growing in the Main Botanical Garden of Academy of Sciences in Moscow and in the botanical garden BIN RAS in St. Petersburg) and *Taxus wallichiana* (growing in the Central botanical Garden, Minsk), which were successfully introduced and acclimatized in botanical gardens of neighboring countries. Of course, the reintroduction needs a highly ornamental *Taxus chinensis*, which has disappeared from cultural flora of Ukraine.

But, in the world collections of botanical garden and parks are 5 species of genus *Taxus*, 2 hybrids and more than 400 cultivars. This is what determines our prospects of introduction of further work on replenishment of the collection of species and cultivars of genus of *Taxus* in Ukraine.

CONCLUSIONS

In Europe *Taxus baccata* appeared at the end of XVI – the beginning XVII century in Great Britain, later yew spread in other European countries. Four species of genus *Taxus* – *Taxus brevifolia*, *Taxus canadensis*, *Taxus chinensis* and *Taxus cuspidata* were introduced in Europe during the middle of XIX – the beginning XX century. In the USA *Taxus baccata* is cultivated from the middle of XVIII century.

At the beginning XX century two hybrids of genus *Taxus*: *Taxus* x *media* and *Taxus* x *hunneweliana* appeared in the private nurseries of the USA.

There are 4 species of genus *Taxus*, 1 hybrid and 15 cultivars in the collections of main botanical organizations of Russia. Four species, 1 hybrid and 10 cultivars grow in collection of botanical organization of Belarus.

It has been shown that in Ukraine the introduction of *Taxus baccata* was began at XVIII century. *Taxus cuspidata* was introduced in the end of XIX century, *Taxus canadensis* and *Taxus* x *media* – in the beginning of XX century.

In the «Olexandria» Dendrological Park genus *Taxus* was found in the end XIX century and now its collection is the largest in Ukraine – 3 species, 1 hybrid and 18 cultivars.

BIBLIOGRAPHY

1. Головкин Б.Н. *История интродукции растений в ботанических садах*. – М.: Изд–во Московского ун-та, 1981. – 114 с.

2. Вольф Э.Л. *Декоративные кустарники и деревья для садов и парков. Их выбор и культура в разных полосах России*. – Петроград: Изд–во Девриена, 1915. – 462 с.

3. Воробьёв Д.П. *Дикорастущие деревья и кустарники Дальнего Востока*. – Л.: Наука, 1968. – 277 с.

4. Деревья и кустарники СССР: Голосеменные [ред. С.Я. Соколов, Д.К. Шишкин]. – М.–Л.: Изд-во АН СССР, 1949. – Т.1. – С. 19–31.

5. Залесская Л.С., Микулина Е.М. *Ландшафтная архитектура*. – М.: Стройиздат, 1979. – 240 с.

6. Каталог дендрологических коллекций арборетума Государственного Никитского ботанического сада. – Ялта, 1970. – 90 с.

7. Каталог деревьев и кустарников ботанических садов Украинской ССР / [Н.А. Кохно, Н.Ф. Каплуненко и др.]. − К.: Наук. думка, 1987. − 72 с.

8. Каталог растений Донецкого ботанического сада: Справочное пособие / [под ред. Е.Н. Кондратюка]. – К.: Наук. думка, 1988. – 528 с.

9. Каталог растений Центрального ботанического сада им. Н.Н. Гришко: справочное пособие / [под ред. Н.А. Кохно]. – К.: Наукова думка, 1997. – 427 с.

10. Каталог рослин дендрологічного парку «Софіївка». Довідковий посібник / [за ред. І.С. Косенко]. – Умань, 2000. – 159 с.

11. Каталог різновидів, культиварів та форм деревних та кущових рослин. Ч.1. Голонасінні (Полісся, Лісостеп та Карпати України) / [С.І. Кузнецов, І.С. Маринич, О.П. Похильченко, Ю.О. Клименко]. – К: Фітосоціоцентр, 2002. – 32 с.

12. Каталог рослин Сирецького дендрологічного парку: довідниковий посібник / [за ред. Л.І Пархоменка, Н.М. Трофименко, А.І. Кушніра та ін.]. – К.: Фітосоціоцентр, 2004. – 88 с.

13. Каталог деревних рослин дендрологічного парку «Олександрія» НАНУ: довідник / [за ред. С.І. Галкіна]. – Біла Церква: БЦФ ТОВ «Дельфін», 2008. – 53 с.

14. Кібкало В.О. *Інтродукція рослин у Краснокутському дендропарку* // Інтродукція деревних та чагарникових рослин в Україні : Зб. тез доповідей. – Краснокутськ, 1993 – С. 81–100.

15. Клименко А.В. *Особенности озеленения монастырских территорий* // Науковий вісник Чернівецького ун–ту. – 2002. – Вип.144. Біол. – С. 157–160.

16. Клименко Ю.О., Клименко А.В. *Старовинні парки Київщини* // Квіти України. – К. – 2003. – 62 с.

17. Комжа А.Л. *Тис ягодный. Красная книга РСФСР (растения)*. – М.: Росагропромиздат, 1988. – С. 464–465.

18. Кохно Н.А., Курдюк А.М. *Теоретические основы и опыт интродукции древесных растений на Украине*. – К.: Наук. думка, 1994. – 186 с.

19. Кохно М.А. *Каталог дендрофлори України*. – К.: НБС ім. М.М. Гришка, 2001. – 54 с.

20. Кохно М.А. *Історія інтродукції деревних рослин в Україні (короткий нарис)*. – К.: Фітосоціоцентр, 2007. – 67 с.

21. Кременецький ботанічний сад. Каталог рослин / Природно–заповідні території України. Рослинний світ. – Вип. 8 – Київ: Фітосоціоцентр, 2007. – 159 с.

22. Крюссман Г. *Хвойные породы*. – М.: Лесная промышленность, 1986. – С. 131–137.

23. Кузнецов С.И., Чуприна П.Я., Подгорный Ю.К. *Деревья и кустарники, культивируемые в Украинской СССР. Голосеменные*. – Киев: Наукова думка, 1985. – 200 с.

24. Лапин П.И., Бородина Н.А., Плотникова Л.С. *Дендрологическая коллекция Главного Ботанического сада АН СССР* // Успехи интродукции растений. – М.: Наука, 1973. – 334 с.

25. Липа О.Л. *Дендрофлора УРСР. Хвойні породи садів і парків УРСР*. – К.: АНУРСР, 1939. – Т.1.– С. 98–108.

26. Лыпа А.Л. *Интродукция и акклиматизация древесных растений на Украине*. – К.: Вища школа, 1978. – 112 с.

27. Манін К. *З Білоцерківського лісництва* // Тр. з с.–г. ботаніки. – Харків, 1927. – Т.1. – Вип.2. – С. 176–178.

28. Небеский А.О. *Списокъ древесныхъ и кустарныхъ породъ растенш акклиматизованныхъ въ саду графа А. Браницкаго близъ Кіева* // Труды отдела ботаники императорского общества акклиматизации животных и растений. – 1899. – Т. 1. – С. 122–131.

29. Регель Э. *Список деревьев и кустарников, произрастающих в Петербурге и его окрестностях* // Записки комитета акклиматизации растений. – М., 1858. – 207 с.

30. Связева О.А. *Деревья, кустарники и лианы парка Ботанического сада Ботанического института им. В.Л. Комарова (К истории введения в культуру)*. – СПб.: Росток, 2005. – 384 с.

31. Третяк П.Р., Гнатів П.С., Щербина М.О. *Дендрофлора ботанічних садів загальнодержавного значення Львівщини* // Наук. Вісник. – Львів, 2000. – Випуск 10.1. – С.133–157.

32. Шкутко Н.В. *Хвойные Белоруссии*. – Минск: Навука і техніка, 1991. – 263 с.

33. Farjon A. *Word Checklist and Bibliography of Conifers*. – Kew: The Royal Bot. Garden, 2001. – 309 p.

34. Keen R.A. *History and development of Taxus in the U.S.* // Proceedings International Taxus Symposium, Ohio Agric. Res. Hort. – 1975. – Ser.421. − P. 2–5.

35. Krussmann G. *Manual of cultivated broad – leaved trees and shrubs*. – Beaverton, Oregon, 1984. – Vol. 1. – 448 p.

36. Price R.A. *The genera of Taxaceae in the southeastern United States* // J. Arn. Arb. – 1990. – № 71. – P. 69–91.

37. Rehder A. *New species, varieties and combinations from the herbarium and the collections of the Arnold Arboretum* // J. Arnold Arb. – 1919. – №1. – P. 44–60.

38. Rehder A. *New species, varieties and combinations from the herbarium and the collections of the Arnold Arboretum. Taxus media hybr. nov., Taxus media f. hatfieldii forma nov., Taxus media f. hicksii, comb. nov*. // J. Arn. Arb. – 1923. – №4. – P. 107–109.

39. Schuett P., Schuck H., Aas G., Ulla M. *Enzyklopedie der Holzgewaechse: Handbuch und Atlas der Dendrologie ecomed*. – Germany, Landsberg am Lech. – 1994. – 479 p.

HONEY PLANTS RESEARCHED BY BOTANICAL GARDEN INSTITUTE OF THE ASM

Maricica Colţun, Liudmila Dombrov

Botanical Garden (Institute) of ASM, Chisinau MD-2002, 18, Pădurii, str.,
e-mail. mcoltun @mail ru. l.dombrov@gmail.com

Abstract: Because bees' life is closely related to honey – pollenous plants, Botanical Garden represents, in addition to other functions, a honey base for bee families in this area. Most honey plants are spontaneous, growing without the interference of man in nature. In recent years, however, there is a growing number of technical crops, fodder, medicinal and aromatic plants, fruit trees and vegetable plants, spanning areas becoming larger. Bees not only gather nectar of these plants to produce honey, but achieve naturally the pollination of plants, which leads to efficient crops, harvesting large quantities.

Key words: bee plants, volatile oil, bees, honey, wood, pole, nectar and culture.

INTRODUCTION

In the spontaneous flora of the Republic of Moldova, are found about 150 species of medicinal plants, of which only a fraction are spread in culture. However, in some regions, medicinal plants are grown on surfaces becoming larger due to the increasing requirements of the industry and the manufacturing of cosmetics. The cultivated areas are important sources for honey bees. Botanical Garden is divided into sectors, exhibitions, includes a variety of trees, shrubs, fruit trees and many species of grass, which provide the families of bees with a nectar-pollenifer collected with different intensities, from March until the frost coming.

MATERIALS AND METHODS

In our country, beekeepers' attention is directed towards combining traditional bee plants with a number of new species introduced in culture in order to enhance the production of nectar and pollen. Among the species that are monitored by beekeepers there are: *Mentha piperita*, *Lavandula angustifolia, Foeniculum vulgare, Pimpinella anisum* L.*, Coriandrum sativum* L., *Cynara scolymus, Dracocephalum moldavica, Melissa officinalis, Borago officinalis, Melilotus officinalis.*

RESULTS AND DISCUSSIONS

Peppermint (*Mentha piperita)* is a perennial herbaceous plant, medicinal and aromatic, with high stem, dark green or reddish, which blooms in June-August, providing bees with nectar and pollen. It is widespread in the culture, being one of the most popular aromatic and honey herbs. The whole plant, especially the leaves of peppermint contains volatile oil. Mint prefers a warm climate with sufficient rainfall. It is quite resistant to cold. It prefers meadow land, light, deep, rich in nutrients, with enough moisture. This plant multiplies vegetatively by cuttings, rhizomes or stolons. Production varies between 800 and 1200 kg per hectare dry leaves. Mint plants help to maintain the activity of bee families, in good condition can provide a picking up for the family of 0.5-2 kg daily and honey production up to 30-40 kg on average. Such crops are recorded about once every 5 years. In the remaining years, the mint is to create good conditions for the growth stimulation of young bees in autumn. Mint is found on the field, natural grasslands, forests, gardens, etc. Honey production is 200 kg / ha.

Lavender (*Lavandula angustifolia* Mill.) is a honey plant, a semi-shrub intensely scrutinized by bees; the essential oil which it contains is used in the pharmaceutical industry. It forms a strong root system, a root and branch wood. Strain forms small clumps 25-60 cm tall, rarely up to 70-80 cm. The bushes have nearly round shape. In a well-branched shrub in full production over 1000 branches are forming inflorescences. Lavender has blue flowers of different shades. No claims to the climate, however, succeed well in regions with enough moisture and warm. Lavender is resistant to frost. Lavender cultures can take up to 12 years. Direct seeding field is in autumn or early spring. It can also be propagated by cuttings and slips. Harvesting begins in the second year of Abib, when most plants are in full bloom, the weather is nice in the morning or evening. Lavender production ranges from 3000-4000 kg per hectare, fresh flowers, from which we can get 10-15 kg volatile oil. Lavender is a good honey plant. Under favorable conditions, it produces more nectar. Following the literature, we can obtain nectar account between 300 and 600 kg per hectare and more. So, lavender is among the most productive plants bees. Long flowering period is 3-4 weeks. Most intense flowering is between the third - sixth year after planting.

Anise (*Pimpinella anisum* L*)*. Herbaceous, annual plant, with a swivel thin root. A strain of up to 75 cm high, cylindrical, corrugated, branched at the top. Basal entire leaves, ovate, with the edge. Small flowers, white, clustered by 5-15 in the umbelula. Fruit - diachene, consists of two pericarps hard separable, oval-shaped and yellow-gray. The seeds contain volatile oil, fatty oil, protein, mucilage, carbohydrates, carboxylic-acid, coumarin hills. The plant prefers light soil rich in humus and calcium, well drained with sufficient moisture. It looks like early spring at a line spacing of 30-40 cm. The seeds are incorporated to a depth of 2-3 cm. An important issue related to

anise is successful culture maintenance. During the growing season, the culture should always be weeded, especially among the young plants. Anise does not support low temperatures as cold wind can damage the crop. Harvesting is done by hand, when the fruit is ripe of 50% and yellow-gray. The plant possesses antiseptic, antispasmodic, aromatic, carminative, digestive and expectorant. It is used as a tonic for the entire digestive system. The volatile oil is used in perfumes and cosmetics industry, in the manufacture of toothpaste and other cosmetic products. The pharmaceutical industry is used for flavoring various drugs. The flowers are visited by bees. A single flower secrete about 0.5-1 mg of nectar, but not all flowers produce nectar from a blossom. The average production of honey can be evaluated from 50-100 kg per hectare.

Fennel (*Foeniculum vulgare*) is a herbaceous, biennial, or perennial plant. The growing season is 10-170 days in the first year and subsequent years, about 150 days. If sown early spring, perhaps even capitalize the first year. The root is well developed, swivel with few lateral branches. The stem is tall, strong branched, glabrous and fistula. The leaves are large, sectioned, with very thin segments, like those of dill. The flowers are grouped in umbelulas and the color of the flowers is golden yellow. The fruit is a diachene, 4-10 mm long, with specific aromatic odor and sweet taste, dehiscent at maturity. Because of the area it originates from, fennel demands heat and light and prefers sunny areas. It has reduced claims against moisture, because it has a well developed root system and a little sweat factor. Drought and prolonged rains during the stages of flowering and fruiting can seriously affect the production. Fennel should be grown on fertile soils rich in nutrients, with shallow groundwater. Being a melliferous plant – crossing is investigated during flowering in summer months. The flowering lasts until late autumn, when given the first frost. Fennel flowers are very much searched by bees when the day is warm. Fennel honey is dark colored, fragrant and with a taste of caramel. It is cultivated for fruits, which contain volatile oil. The main component of the essential oil is anethole, which provides the therapeutic effect. Besides volatile oil, fruits also contain fatty acids, fiber, carbohydrates, ash.

Caraway (*Coriandrum sativum* L.). Eurasian species with ecological plasticity, which can be found in the spontaneous flora. In order to obtain constant and annual production of good quality, caraway was added to the culture and cultured on small surfaces. It is biennial, rarely perennial with root systems, 1.5-2 cm thick fleshy white. In the first year, it develops a rosette of basal leaves, and in the second, a high strain up to 100 cm, fistula, branched over the top, spaced foil. Leaves are 2-3 pinnate section, the lower long petiole 6-12 pairs of segments. Umbelula consisting of radii 5-15 uneven wearing composed umbelule. The fruit is a dischene composed of two free mericarpes. It blooms from April to July. The fruit contains volatile oil, consisting of carvone, carveola, carvacrol, limonene, dehydrocarvone, dihydrocarveol. Caraway

can withstand low temperatures. It has to be cultivated in order to give high yields on fertile soils rich in nutrients. Sowing, in spring, runs in the first emergency. Distance between rows is 30-40 cm and 15 cm between plants. Sowing depth is 2-3 cm. Complex chemical composition of the fruit, give them the incentive properties of gastrointestinal secretions, carminative, stomachic, galactagoge. Removes bloating and improves mental patient influence smooth muscle tone, stimulating resorption of gas in the blood vessels. Caraway fruits are widely used in food industry, bakery pastry preparations, as a spice or flavoring for alcoholic beverages. The flowers produce abundant nectar that lures a large number of bees. It blooms in June.

Artichoke (*Cynara scolymus)* a species native to the Mediterranean, where it is widely cultivated as a vegetable plant. In Republic of Moldova, the artichoke is introduced and investigated as a medicinal plant. It is a perennial, herbaceous plant, with straight stem, very branched hairs though irregular, soft. The root is thick, pivoting, deep in the ground, sometimes with branches. The leaves are large, penatifide, whitish green color on the top, the bottom tomentose. The flowers are grouped in calathidiums. The fruit is an oblong achene. It blooms from July to October. Cynarin leaves are rich in polyphenols and flavones; contain a bitter principle called cynaropicrin, glycosides, mucilage, tannins, pectins, luteolin, phytosterols, insulin, enzymes, volatile oil, acids and minerals. An artichoke, being a species of warm area is very sensitive to low temperatures. It grows in areas with mild winters, the ground covered with snow and sheltered places with southern exposition. Usually in the cold season is transferred to the greenhouse. In some warmer winters, plants, protected by hiller, do not freeze. The plants are grown on soils rich in nutrients, with neutral reaction with deep groundwater. Propagation is by seed although the vegetative propagation is also recommended. There was obtained, on average, 3000 kg / ha dried leaves. Artichoke leaf extracts can be characterized in terms of pharmacodynamic through three properties: the choleretic, diuretic action and action on cholesterol metabolism. The artichoke blooms in the second half of July and lasts until the end of August, being intensely searched by bees; the honey production is estimated at 200 kg / ha.

Moldavian dragonhead (*Dracocephalum moldavica)* is a herbaceous, annual, cultivated for the production of essential oil and honey purposes. The strain is 40-70 cm tall. It blooms from July to September. The nectar secretion is greater when the pollen sacs open until the stigma matures. Meanwhile, the nectar climbs the narrow tube into the larger floral flower, filling it up to a third and becomes easily accessible to bees. At the time of ripening, the average nectar of flowers reaches up to 2 mg. If the weather is dry, the nectar secretion is reduced by half, but not interrupted. The nectar is transparent, colorless, with a high percentage of sugar and has a pleasant aroma of lemon. Depending on weather, the nectar consistency varies. The bees are collecting more intensively nectar of flowers and little pollen. The abundant nectar production is

due to the intense secretion of a large number of flowers. The production of honey is an average of 200-250 kg / ha. The honey is light and of high quality.

Lemon balm (***Melissa officinalis* L.**) is an aromatic, honey plant, with healing properties; it grows spontaneously in the woods, thickets and clearings. It is cultivated for its properties which attract bees. The name comes from the use of lemon balm plant to capture and settlement clusters in hives. It is a herbaceous perennial plant that forms a branched stem, which in cross section is square, porous, 30-100 cm high. It blooms in June-August. It is a cold sensitive plant that grows well in southern and warmer regions. We exhibit this increase in sunny places, protected from cold winds and frost. This plant prefers medium soils, moderately deep sandy loam. Propagation is by seed. Production varies between 1500 and 2500 kg / ha of dry leaves. It provides large amounts of nectar for bees, that is hardly extracted and the most is used by bumblebees. Honey's taste and aroma are fine and pleasant. Honey production is 150 kg / ha.

Borage (*Borago officinalis*) is an annual honey, herbaceous plant. The stem is 50-60 cm tall, branched, covered with stiff hairs, with petiole leaves and peak sessile, with large blue flowers, gathered in inflorescences. The young flowers and buds are pink. Flowering lasts 35-40 days from mid-summer to September and even October. The nectar secretion is very abundant, the most intense after the pollination period until fertilization. Towards the end of flowering, the nectar production decreases significantly. The nectar is transparent, colorless and odorless. Borage flowers are very well searched by bees. In addition to nectar, the bees gather the pollen. Sometimes, in the same flower, 2-3 bees can be found. The nectar production, after determinations made by researchers, in favorable conditions, is valued at approx. 200 kg per hectare. The flowers are harvested when they start to wilt, to enable the bees to use them.

Sweet clover (*Melilotus officinalis*) is a herbaceous species found in orchards, fields, roadsides, including crops, the meadows and cultivated fields, which is different from the other herbs in its height. The most common species in the wild flora are yellow melilot and white sweet clover, annual and biennial forms. It contains an aromatic substance called coumarin. It is undemanding to the climate and soil. It succeeds to grow well in the steppe region, is resistant to drought. It is a good green manure, enriching the soil with nitrogen. Pure culture is like early spring in rows spaced dense. The vegetation period is long. The biannual mellifera is yellow sweet clover. The flowers of this variety are yellow and fragrant. In all forms of melilot, the nectar production is lengthy. White sweet clover produces 200 kg ha honey. The honey is almost colorless. White sweet clover produces annually from 130 to 150 kg ha honey.

CONCLUSIONS

Through this collection, we aim to offer the visitors of the Botanical Garden, a better knowledge of this type of plant, so valuable content resources by bees, considered as natural treasures. In addition to color images of each species of plants, plant information content is to present a systematic point of view, geographical, biochemical, and in terms of the value of honey value. The advantages of introducing the culture are well known in the production of honey and by very long flowering periods, covering the need for picking bees, especially during the summer and early automn, when the flowering is poor.

BIBLIOGRAPHY

1. Gheorghe Mocan, *Tratarea bolilor cu plante medicinale*, Publisher Corint, Bucharest, 2006.

2. Constantin Pârvu, *Universul plantelor*, Publisher ASAB, Bucharest 2006.

3. John Heinerman, *Miracle Healing Herbs*, Publisher Preantice Hall, USA, 1998.

4. Grigore Musteaţă**,** *Cultivarea plantelor aromatice*, Chişinău, Publisher Cartea Moldovenească, 1980.

5.Petre Iordache, Ileana Roşca, Mihai Cismaru. *Plante melifere de foarte mare pondere economică apicolă*. Publisher Lumea apicolă. Bucharest 2008.

6. Ovidiu Bujor. *Ghidul plantelor medicinale şi aromatice de la A la Z.* Publisher Fiat LUX 2003.

7. Florentin Crăciun, Mircea Alexan, Carmen Alexan. *Ghidul plantelor medicinale uzuale*, Publisher ştiinţifică, Bucharest 1992.

8. Cârnu I.V. Flora mileferă. Publisher Ceres, Bucharest, 1980.

PECULIARITIES OF ENERGY PLANTATION FORMING IN RIGHT-BANK FOREST-STEPPE OF UKRAINE

Lubov Ishchuk

Bila Tserkva National Agrarian University,
Ukraine, Kiev an area, city Bila Tserkva, Soborna area, 8/1

Abstract. The article gives the estimation of the state and perspectives of phyto-energetic development in Ukraine based on the analysis of literature and Internet sources. There are approximately 2 millions hectares of land excluded from agricultural use in Ukraine, which is suitable for energy plantation forming. Economically feasible potential of biomass in Ukraine is about 30 million tons per year, including the main components – agricultural residues and energy crops. Leading species for forming energy plantations in Ukraine are *S. viminalis* L., *S. acutifolia* Willd., *S. triandra* L., *S. purpurea* L. The estimated cost of producing one ton of fuel from one willow is 400UAN. Owing to its high calorific power willow is the competitive fuel. For example, 1 ton of dry willow replaces 1.12 tons of straw, 0.43 tons of rapeseed oil, 0.46 tons of fossil coal, 0.8 tons of brown coal, 0.37 tons of fuel oil, 0.73 thousand m^3 of biogas and 0.51 thousand m^3 of natural gas. Depending on soil and climatic conditions, from 15-20 to 30-40 thousand of annual cuttings are planted per hectare to form industrial plantations. For plantation preparation, weeds are sprayed with herbicides. Plowing, disking and harrowing the soil are the necessary procedures before planting. The plantation care involves cultivation between rows, fertilization, mowing weeds between rows and soil loosening. The first harvest is carried out after 3 years from the time of planting. Thus, the estimate for the forming of energy willow plantation before the first growth is 20155UAH. As a result of incurred expenses, we are able to get 22 tons per hectare every three year within 25-30 years. The development of bio energy plantations for fast-growing wood will solve a number of economic, environmental and social issues of today.

Key words: biomass, energy willow, energy plantation, bio energy plantation, energy independence.

INTRODUCTION

In recent years, rapid global climate changes and limitation on conventional heating raw materials amount stimulate the search for new energy sources, using bio energy crops for different types of bio fuels. In industrialized countries, solid bio fuel plays a significant role in the energy supply; particularly in the United States it accounts for approximately 4%, in Denmark – 6%, in Canada – 7%, in Austria – 14%, in Sweden – 16% of the total primary energy consumption. It should be noted that the alternative energy sources cover energy requirement in Austria – 22%, Sweden and Norway – 45-55%. Besides Germany, Austria, Sweden and Norway are planning fuel switching to the end of this century (Energy Strategy of Ukraine, 2009; Investment Forum, 2010; Habrel M., 2011).

Based on the UN Program materials, the part of renewable energy sources in the global fuel and energy balance in 2050 could reach 50%, according to the World Energy Council calculation, at the end of this century it will reach 80-90%. Thus, biomass ranks the fourth place among the other fuels and provides 14% of world's total primary energy consumption, moreover in developing countries – more than 30%, sometimes up to 50-80% (Energy Strategy of Ukraine, 2009; Biomass Action Plan for Ukraine, 2009; Investment Forum, 2010; Osaulenko O., 2010).

In Ukraine phyto-energetic may become an upcoming trend of agricultural development. To achieve this we have the soil and climatic conditions to grow crops with high vegetative mass in large quantities. The development of bio energy technologies will reduce Ukraine's dependence on importing energy resources, improve energy security on account of energy supply by using local renewable resources, create a significant number of new workplaces, and will make a significant contribution to the improvement of the environmental situation.

Economically feasible potential of biomass in Ukraine is about 30 million tons per year, with its main parts – agricultural residues and energy crops.

The National Energy Program of Ukraine, which was approved in 1996 by Verkhovna Rada of Ukraine, provides a supply of a 10% energy-requirement of National Economy on account of using non-traditional renewable and other energy sources. Following the experience of the EU (where the part of biomass is 60% of all renewable energy), biomass can cover about 6% of energy-requirement of Ukrainian National Economy (Perebora S., 2008; Biomass Action Plan for Ukraine, 2009; Investment Forum, 2010; Osaulenko O., 2010; Proskurina O., 2011).

Ukraine has a great potential for forming and developing bio energy plantations for fast-growing wood. Indeed, there are approximately 2 millions hectares of land excluded from agricultural use in Ukraine, which is suitable for energy plantations forming. Involvement of biomass specifically grown on land that is not used in agriculture, particularly on land contaminated – 15 Ky/km or used inefficiently in Ukraine will increase the share of biomass in the energy balance of the country up to 20-25%. With the country's own energy insecurity and lack of state budget, creation and development of bioenergy plantations opens the way for economic and energy independence of Ukraine (Perebora S., 2008; Biomass Action Plan for Ukraine, 2009; Osauleko O., 2010; Proskurina O., 2011).

Leading woody energy plants in Europe are willows. Therefore, the technologies of growing and use of Swedish energy willow bio fuels are extensively studied in Ukraine. The first class of Swedish energy willows adapted for Ukraine are 'Inger', 'Clara', 'Lisa', 'Stena'. This is a plant with high weight gain (30-40 tons of wood pulp per hectare).

LLC «Holland Alma» is a Hungarian business, which products planting stock of energy willow and works out the technology adapted for Eastern European countries.

National enterprise «Holland Plant Ukraine» holds rights to reproduction and distribution of these species in Ukraine. In Ukraine there is an already built orchard and also demonstration plantations of these kinds of willows.

MATERIALS AND METHODS

The project aim is to develop the technology of growing and use of bio fuels, resulting from energy willow plantation growing and used for heating buildings in rural areas of Ukraine.

Regulatory support of energy willow crops in Ukraine is the Law of Ukraine No. 555-IV «On Alternative Energy Sources», dated 21.10.2008, the Law of Ukraine No. 1391-XIV «On Alternative Kinds of Fuels», dated 21.05.2009, the Law of Ukraine No. 411-IV «On Seeds and Planting Material», dated 09.12.2010. The cost of energy plantations forming and operating is calculated on the basis of existing standards of Ukrainian forestry, time and fuel consumption (Recommendations for growing technology, 1992; Rate of production and standards of fuel consumption, 2007, Rate of production of forest cultivation, forest-protection and fire-prevention work, 2007).

RESULTS AND DISCUSSIONS

Increasing profitability of growing plants for energy purposes has attracted the attention of farmers. Industrial energy willow plantations are constructed in Rivne, Lviv, Ivano-Frankivsk, Vinnytsia, Volyn oblasts of Ukraine (About growing energy willow saplings in Rivne Oblast, 2010).

The notion «energy willow» includes several species of fast-growing willows. The most popular is basket willow (*Salix viminalis* L.). Autochthonous marsh elders also have energetic properties, including *Salix acutifolia* Willd., *S. triandra* L., *S. purpurea* L. with phytomass growth of 1.0-2.0 per year. These are the species with sparse areal, major reserve stocks and broad ecological range.

The energy willow has many advantages. For example, they are undemanding for soil capabilities, they can easily propagate with sclerotic cuttings, they are relatively disease and insect resistant, undemanding to the climatic conditions, and therefore considered to be low cost plants.

Depending on soil and climatic conditions, from 15-20 to 30-40 thousand annual cuttings are planted per hectare to form industrial plantations (Borovyk G., 2007). The distance between the cuttings should be 35-40 cm, the distance between the rows – from 70 to 150 cm. Depending on the ways of collecting, cuttings are planted in two or three blades. Harvesting is carried out during the autumn and winter period with special or traditional forage harvesters, as plant diameter rarely exceeds 12-15 mm. The first harvest is carried out after 3-4 years from the time of planting, when the saplings reach 5-6m. The period of using the plantation is 25-30 years. The raw

material is chopped, dried and converted into pellets for future burning in boilers. Spring plants renew vegetative mass from stubs.

The estimated cost of producing one ton of fuel from one willow is 400 UAN. Heat transfer from willow wood burning is 16 MJ/kg, which makes it to be the competitive fuel. In particular, heat transfer from the burning wood of trees such as oak and pine are respectively 14.1 and 13.8 MJ/kg, from straw – 14.3 MJ/kg. Of course, fossil fuels' heat transfer is higher; anthracite heat transfer is 30.0-35.0 MJ/kg, brown coal – 10.0-20.0 MJ/kg, and natural gas – 31.7 MJ/m^3. Owing to its high calorific power, willow is the competitive fuel. For example, 1 ton of dry willow replaces 1.12 tons of straw, 0.43 tons of rapeseed oil, 0.46 tons of fossil coal, 0.8 tons of brown coal, 0.37 tons of fuel oil, 0.73 thousand m^3 of biogas and 0.51 thousand m^3 of natural gas (About growing energy willow saplings, 2010; Bielokur S., Vaskin R., 2013).

Such plantations are created in order to get biomass, which is used to produce ethanol, butanol and biogas, and solid biofuel processed to briquettes and pellets.

Let us consider the calculation and analysis plan for creation of willow bio energy plantation in Ukraine. For our calculations we take one hectare of land, excluded from agricultural use, where the energy willow plantation will be formed. The planting material is annual cuttings of 20 cm, the planting scheme is as follows: row-spacing – 75 cm, distance in a row – 33 cm, the requisite quantity of cuttings per hectare is 40 000. As biomass is stored up usually after 3 years, the expenses are also counted for years.

Annual cuttings are prepared during the first year. For plantation preparation, weeds are sprayed with herbicides. Plowing, disking and harrowing the soil are the necessary procedures before planting. The first year plantation care involves fertilization, on the basis of active ingredient of nitrogen – 30, phosphorus – 10 and potassium 80 kg/ha. The first year plantation care also involves triple cultivation between rows (Table 1).

Table 1

Estimate for the forming of energy willow over an area of one hectare

No.	Work type	Expenses for years of culture		
		The first one	The second one	The third one
1	Stocking up annual cuttings	1205	-	-
2	Spraying weeds with herbicides for plantation preparation	1500	-	-
3	Plowing the land (average soil)	200	-	-
4	Disking	65	-	-
5	Harrowing	45	-	-

6	Fertilizer application	350	835	835
7	Cuttings planting	3200	-	-
8	Cultivation	1000	-	-
9	Mowing weeds between rows	-	2850	2850
10	Soil loosening	-	2550	2550
11	Biomass stocking up	-	-	120
12	Costs per year	7565	6235	6355
13	The total costs	20155		

Second and third year plantation care involves annual fertilization, on the basis of active ingredient of nitrogen – 80, phosphorus 30 and potassium 80 kg per hectare. The second and the third year demands mowing weeds between rows (2 times) and soil loosening.

CONCLUSIONS

Thus, the estimate for the forming of energy willow plantation before the first growth is 20155 UAH. As a result of incurred expenses, we are able to get 22 tons per hectare every three year within 25-30 years. Stocking up the cuttings for planting over the area of 5-7 ha is also possible.

The project of forming and developing bio energy plantations for fast-growing wood in Ukraine has a great potential and a lot of prospects. The article reveals some ecological and economic prospects for forming and developing bio energy plantations in Ukraine:

- the use of vacant lands for forming bio energy plantations;
- reducing the budget deficit, which is the result of the debt to the energy importing countries;
- energy independence;
- the use of a rather cheap source of energy;
- the improvement of the environmental situation in the country;
- minimization the threat of global warming;
- the use of green power.

Thus, the development of bio energy plantations for fast-growing wood will solve a number of economic, environmental and social issues of today. Using the resource potential of Ukraine completely, that is agricultural land afforestation, gives an opportunity to get the renewable energy source as biomass. New technologies of biomass conversion and its use in the energy industry of Ukraine offer the ability to create energy-independent country.

BIBLIOGRAPHY

1. About growing energy willow saplings in Rivne Oblast (2010-2011), 2010: <oblrada.rv.ua/.../5_sklikannya.php?...ID=37

2. Bielokur S., Vaskin R., Environmental aspects of the use of bio fuel from energy willow. Modern technologies in the commercial manufacture: the materials of science and technology conference of professors, post-graduate students and students of the faculty of engineering systems and energy efficient technologies. Sumy: SymDY, 2013, Ch.2: 159-160.

3. Biomass Action Plan for Ukraine : http:// www.biomass.kiev.ua.

4. Borovyk G., Energy Grove. Agrosector. 2007. №2 (16): 13-14.

5. Energy Strategy of Ukraine until 2030 : http:// http://mpe.kmu.gov.ua/fuel/control/uk/doccatalog/list?currDir=50358

6. Habrel M. S., The production of solid bio fuel in Ukraine: the state and progress prospects ISBN 5-7763-2435-1 // Scientific Journal of The National Forestry and Wood-Technology University of Ukraine. Lviv, 2011. № 21.9. P. 126-131.

7. Investment Forum «Ukraine – Germany: joint bio energy projects», Kyiv, 21-22.07.2010. : http:// www.east-west-bioenergy.net.

8. Kaletnik H., The development of the bio fuels market in Ukraine. Kyiv, Agricultural Science, 2008 : 1-461.

9. Osaulenko O. H., Statistical yearbook of Ukraine (2009) / ed. by A. H. Osaulenko. M. : Information Analysis Center, 2010 : 568 p.

10. Perebora S. V., 2008, Economic and social perspectives of the creation and development of bio energy plantations for fast-growing tree species in Ukraine. Innovative potential of Ukrainian science – the twenty-first century: < http:// www.nauka.zinetinfo.

11. Proskurina O. V. Prospects for production and use of bio fuel in Ukraine // Theoretical and practical aspects of economics and intellectual property. 2011. №1. : 12-15.

12. Recommendations for growing technology of planting stock for forming industrial plantations of various purposes, Vinnytsia: «Lies» 1992 : 1-37 p.

13. The Law of Ukraine № 555-IV «On Alternative Energy Sources», dated 21.10.2008. < http:// www.zakon.rada.gov.ua >

14. The Law of Ukraine № 1391-XIV «On Alternative Kinds of Fuel» dated 21.05.2009. < http:// www.zakon.rada.gov.ua. >

15. The Law of Ukraine № 411-IV «On Seeds and Planting Material», dated 09.12.2010. < http:// www.zakon.rada.gov.ua >

16. The rate of production and standards of fuel consumption for planting stock growing in nursery forest gardens, Kyiv, «UKRDNIPROLIS», 2007 : 1-78.

17. The rate of production of forest cultivation, forest-protection and fire-prevention work, Kyiv, «UKRDNIPROLIS» 2007 : 1-164.

18. Shchokin A. R., Kolesnyk Y. V., Novak A. H., Tsyhankov S. P. Prospects for production and use of bio fuel in Ukraine // Electronic Journal of ESCO «Ecological Systems». 2003, №5. http:// www.necin.com.ua.

THE GARDENS OF MEDICINAL PLANTS AS A MEANS OF PRESERVATION AND RATIONAL VALORIZATION OF BIOACTIVE COMPOUNDS

Angela Mărculescu[1], Gheorghe Olteanu[2]

[1] Transilvania University of Brasov, România

[2] National Institute of R-D for Potato and Sugar Beet, România

Abstract. This paper highlights medicinal and aromatic herb gardens as a means of real preservation and effective utilization of biologically active substance. As forms of organization we have targeted direct impact on certain segments of the population – rural residents and visitors to these areas, manufacturers of herbal products, personnel from monasteries and pilgrims coming here, environment researchers dealing with the recovery of biologically active substances from green natural resources. We focus on three types of gardens: 1. Medicinal and aromatic plants gardens in the natural environment, 2. Medicinal and aromatic plants gardens around the peasant households, guesthouses and small agroproducers of herbal products, 3. Medicinal and aromatic plants gardens from Romanian monasteries. All these can form databases for research in this area – an objective which The Romanian Society of Ethnopharmacology intends to capitalize by editing The Romanian Traditional Pharmacopeia.

Key words: gardens, medicinal plants, bioactive compounds.

INTRODUCTION

Given the outstanding concerns inside current Romanian research in the exploitation of natural resources joint with native species conservation and rational use of natural biologically active substances, Romanian Society of Ethnopharmacology together with researchers from specialized centers are pursuing the most effective methods of preservation and utilization of medicinal and aromatic plants in the Romanian area.

The study conducted on monographs of medicinal and aromatic plants (in various forms for use) present in the Romanian Farmacopoea (1), (FR I 1862, FR II 1874, FR III 1893, FR IV 1926, FR V 1943, FR VI 1948, FR VII 1956, FR VIII 1965, FR IX 1976, FR X 1993), found that the interest in medicinal and aromatic plants was a major one in the first edition of the Farmacopoea remarking a proportion of 60% monographs of medicinal and aromatic plants while in the FR V and VI editions there is a regression of synthetic chemicals in favor of ACARE. After that we are

witnessing again a growing interest for new natural compounds. Currently, production units for herbal supplements have increased the interest in exploiting these invaluable resources.

The current situation of medicinal and aromatic species used in pharmaceuticals, cosmetics, foods or supplements can be summarized as follows:

- species already included in one of the Romanian Farmacopoea editions;
- species of wild flora or culture currently used but not included in any of the ten editions of the Romanian Farmacopoea (eg. *Hippophae rhamnoides, Artemisia abrotanum, Geranium macrorrhizum, Chrysanthemum balsamita, Alchemilla vulgaris* etc.);
- species that are found in significant quantities in the wild flora that have been traditionally used and are used by manufacturers of nutritional supplements based on their research in composition and toxicity (eg. *Hippophae rhamnoides, Ruscus aculeatus, Hedera helix, Clematis vitalba, Aristolochia clematitis, Filipendula ulmaria, Alchemilla vulgaris* etc.);
- introduced species in culture at the request of producers or grown in their farms (eg. *Angelica archangelica, Chrysanthemum balsamita, Ocimum basilicum, Trigonella foenum-graecum, Geum urbanum, Valeriana officinalis, Vinca minor,* etc.);
- species of foreign origin which were successfully acclimatized and grown in Romania and used in the production of phyto (eg. *Leuzea carthamoides, Echinacea angustifolia, Arnica chamissonis* etc.);
- varieties created by Agronomic Research (selection and improvement) with increased biochemical content of active substances and resistant to pests and diseases (eg. *Papaver somniferum, Vinca minor, Lavandula officinalis* etc.);
- medicinal species used since empirical medicine – remedies of herbalists or remedies obtained in monasteries (*Vitis vinifera, Oleo europea, Chelidonium majus, Rumex acetosella, Viola tricolor* etc.).

Given these data and the availability of Romanians for the cultivation and exploitation of medicinal species, in this paper we try to promote the gardens of medicinal and aromatic plants as a means of conservation and optimum use of natural resources and at the same time as a means to increase the quality of life in rural areas.

MATERIALS AND METHODS

In this paper we present one such experiment conducted in the tourist village Şirnea – a village situated at the foot of Piatra Craiului, in the mountain region of the Land of Bran. The place possesses a great diversity and abundance of medicinal, aromatic and food plants [2].

The medicinal species most known, appreciated and empirically used in the region

are: *Plantago lanceolata, Taraxacum officinalis, Origanum vulgare, Thymus serpyllum, Rumex acetosa, Gentiana asclepiadea, Symphytum officinalis, Hypericum perforatum, Alchemila vulgaris, Gentiana lutea, Centaurium umbelatum, Achilea millefolium, Arnica montana, Verbascum phlomoides.*

Among the species cultivated in the gardens of villagers in Şirnea - as ornamental, aromatic or therapeutic we can specify: *Ocimum basilicum, Artemisia abrotanum, Mentha piperita, Thymus serpyllum, Chrysanthemum balsamita, Geranium machrorrizum, Calendula officinalis.* We used three working methods for the proposed objective of this paper:

- the method of protecting and increasing natural basins in collaboration with landowners. Among the species represented in the region include: *Arnica montana, Hypericum perforatum, Alchemila vulgaris, Symphytum officinalis, Galium mollugo, Thymus pulegioides, Verbascum phlomoides.*
- the method of introducing the culture of some species already known by tradition. In the peasant gardens and landscaped gardens belonging to guesthouses we targeted the introduction of the following species: *Ocimum basilicum, Artemisia abrotanum, Mentha piperita, Thymus serpyllum, Chrysanthemum balsamita, Geranium machrorrizum, Calendula officinalis,. Angelica arhangelica.*
- the method of cooperating with monasteries in the area for the enhancement of the existing ornamental and aromatic gardens with some of medicinal species with therapeutic properties including: *Hysopus officinalis, Geranium machrorizum, Artemisia abrotanum, Chrysanthemum balsamita, Achilea millefolium, Ocimum basilicum, Calendula officinalis, Lavandula officinalis.*

RESULTS AND DISCUSSIONS

We initiated the implementation of this project in Şirnea – the first tourist village in Romania – located in the mountainous part of the Bran region. We initiated three directions in the organization of aromatic herb gardens in Romania, namely:

- **Medicinal and aromatic gardens in natural conditions**

  Thus, we enriched natural basins of spontaneous flora using the method of spontaneisation [3]. Thus ensuring both existing plant conservation and optimal conditions for growth and multiplication in their natural habitat. In this experiment the plants that responded best to the actions taken were: *Arnica montana, Hypericum perforatum, Alchemila vulgaris, Symphytum officinalis, Galium mollugo, Thymus pulegioides, Thymus commosus, Verbascum phlomoides, Achilea millefolium, Viola declinata, Heleborus purpurascens.*

By alerting and informing citizens, they become aware of the land they own and begin to love plants that they grow, enjoy the yard and their hills and are ready to welcome their guests and share these God's gifts.

➢ **Herb and spice gardens around village households and farms for rural tourism**

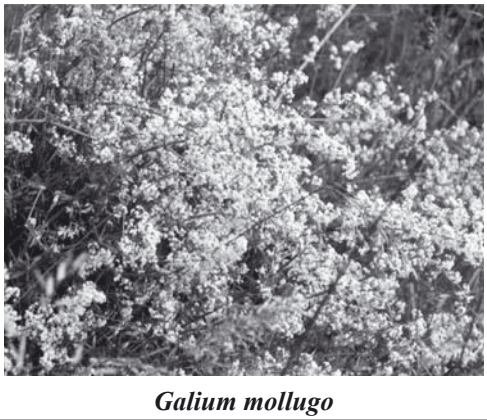
These gardens have a special value by allowing exploitation of medicinal and aromatic species in several respects:

- Aromatherapy in the space near the house or guesthouse.
- Preparation of tea plants in the garden.
- Cosmetic and plant treatment with plants from the garden.
- Direct meeting and experience of visitors with medicinal plants in the area, their knowledge and foster respect for the natural riches.
- They can be run as preparatory organization for larger areas cultivated by producers of food supplements and phototherapeutic products.

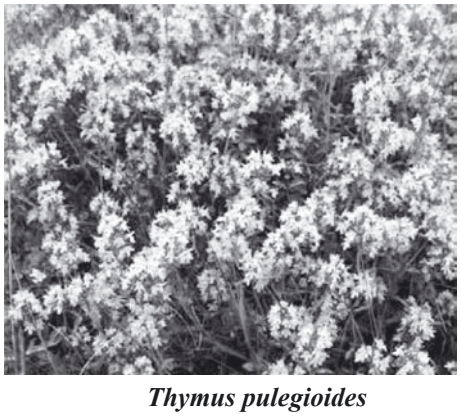
Among the plants best adapted to this kind of gardens include: *Calendula officinalis. Angelica archangelica, Artemisia abrotanum, Thymus serpyllum, Chrysanthemum balsamita, Geranium machrorrizum, Ocimum basilicum, Mentha piperita, Origanum vulgare.*

Alchemila vulgaris

Arnica montana



Galium mollugo



Thymus pulegioides

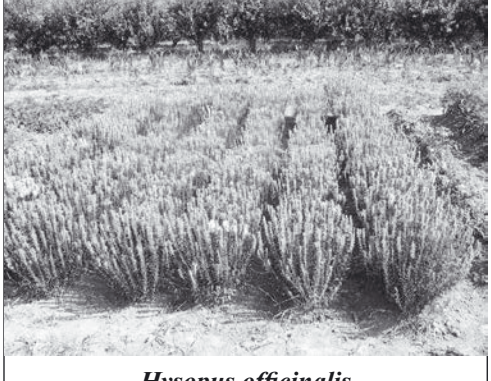
- **Medicinal and aromatic plants gardens in Romanian monasteries**
  Monasteries are places where traditional remedies still find a privileged place, they even become inspiration for producers of herbal products at industrial level. Monasteries have always been God's gardens – where ornamental aromatic and medicinal plants have a very strong vitality.
  Therefore we believe that from the development of such gardens can benefit both monks and pilgrims coming to monasteries. Spiritual therapy that pilgrims expect in these areas may be accompanied by phytotherapy and aromatherapy. In addition the relationship man – natural herb can acquire new approaches.

This paradise of roses and other ornamental plants could be joined in the monastery gardens by medicinal and aromatic plants, out of which we recommend: *Hysopus officinalis, Geranium machrorizum, Artemisia abrotanum, Chrysanthemum balsamita, Achilea millefolium,Ocimum basilicum, Calendula officinalis, Lavandula officinalis.*

Geranium machrorrizum

Calendula officinalis

Mentha piperita



Hysopus officinalis

CONCLUSIONS

The three models of aromatic herb gardens that we offer come to bring added value to rural activities. They may be true data banks on indigenous medicinal species, some of them even endemic, that can be known and used by households in rural areas but can also lead to new ideas for generating productive activities in rural areas focusing on these resources.

Knowing the value of medicinal and aromatic plants in these gardens in natural space, neighborhood houses and guest houses, in and around the production units, we want to increase the sense of conservation and protection of nature and the interest for more efficient exploitation of these resources.

BIBLIOGRAPHY

1. Mărculescu Angela, Drăgulescu C., Lupescu Irina, Hanganu Daniela – Componenta vegetală a farmacopeelor romane, Acta oecologica vol.XI, 1-2, 2004, p.39-65 ISSN 1221-5015.

2. Drăgulescu Constantin – Darurile Şirnei, Flora, Editura Universităţii Transilvania Braşov, 2013.

3. Alexan Mircea – Teza de doctorat: Spontaneizarea, metodă de conservare a speciilor medicinale, Universitatea Bucureşti, 1987.

4. Alexan Mircea, Ovidiu Bojor, Florentin Crăciun – Flora medicinală a României, Editura Ceres, 1988.

THE COMPLEX RESEARCH OF INTRODUCTION PLANTS OF *NYMPHAEA GIGANTEA* HOOK

T. P. Mazur, N. V. Nuzhyna, A. Ya. Didukh

The Botanical garden named after O. V. Fomin of ESC "Institute of biology" of Taras Shevchenko National University of Kyiv. S. Petlyury (Cominterna) 1 Str, Kyiv 01032, Ukraine.

Abstract. The complex research of *Nymphaea gigantea* Hook plants introducing in greenhouse of water and coastal-water plants of Botanical garden named after O. V. Fomin was done. The peculiarities in structure of floating and above-water leaves of a plant were proved by anatomical researches.

Key words: introduction, greenhouse, nymphaea gigantea.

INTRODUCTION

Among the floral biodiversity the water plants and their groups get the most anthropogenic influence and vanish because they are rather sensitive indicators of the condition of the aquatic environment. That is why most of them are included to the "Red lists" or "Red books" of the different regions of the world. The role of water plants in a biogeochemical cycle of matter and energy, in the process of self-purification of ponds is a great one and it is difficult to overestimate it. Water plants less depend on climate conditions as compared to ground-based plants that is why relic, rare genera and species among them have remained for present days. The development of *Nymphaeaceae* Salisb. family members goes back to Cretaceous period. One of the ways of protecting the plants of *Nymphaea* L genus is their introduction in the conditions of protected soil. The works on introduction and protection the members *Nymphaeaceae* family have been carrying out for 40 years in Botanical garden named after O. V. Fomin. The important stage for positive results is a complex studying of bioecological peculiarities of the species and their ontogenesis in conditions of *ex situ*.

MATERIALS AND METHODS

The object of our research were *Nymphaea gigantea* Hook plants taken from the collection of the Botanical garden named after O. V. Fomin of Taras Shevchenko National University of Kyiv. The seeds of *N. gigantea* were received in 1986 from

St. Peterburg (Russia) Botanical Garden of BIN, their inventory number is 80586. For more detailed studying of the plants of this genus the methodology of modeling the control conditions of existence (similar to natural conditions) in artificial ponds in greenhouse conditions of the Botanical garden was used.

The systematical analysis of the *Nymphaeaceae* family representatives was experimented on the systems of A. L. Takhtadzhian [9], R. K. Brummitt [11]. The biomorphological peculiarities of the plants were described on the basis of E. G. Serebryakov's [8], O. E. Vasiliev's [2], F. Henkel's, F. Rehnelt's, L. Ditman's works [14]. The periods of ontogenesis were studied on the basis of T. A. Rabotnov's [7], A. A. Zhukova's works [3]. The colours of plant's organs were observed with the scale of the colours of A. S. Bondartsev [1]. The characteristic of the climate conditions of the natural distribution was composed on the basis of scientific literature, such as: S. Hejný [12; 13], D. X. Campbel [4], A. L. Takhtadzhian [10] and M. E. L'vovych [5].

For anatomical studies, the floating and above-water leaves of *N. gigantea*, collected in the phase of 2–3 days after disclosure were used. The samples were fixed according to Chamberlain. They were coated with gelatin by the standard method and leaf cross-sections (each 10–15 microns in width) were made with the help of a freezing microtome. The sections were stained with safranin. Also the prints of leaves' epidermis from the adaxial and abaxial leaf surfaces in the daytime were performed. The microscopic measurements were carried out using an eyepiece-micrometer on microscope XSP-146TR. The obtained data were statistically processed with the help of program Statistica 6 on $P \leq 0,05$ confidence level. The pictures were taken with the digital camera Canon Power Shot A630.

RESULTS AND DISCUSSIONS

Studying biological peculiarities of *N. gigantea* it was determined that they are spread in lakes and in marshes of Australian tropics, and also they are spread on the North of Arnhemland peninsula. The climate in natural grow of species is tropical monsoon. This is the region of moisture tropical forests, where annually falls 2000-4000 mm of atmospheric precipitations with equal distribution. The air temperature is +25–30°C. The difference between the cold and warm season temperatures does not exceed +1–6°C. The type of the river regulation is amurensis, that is characterized by the advantage of summer flowing and averages 85–95% per year. Winters are dry and summers are hot but with strong rains.

Nymphaea gigantea is a perennial herbal tuberiform plant. The underground shoots are elongated, the tubers are (8±0.2) cm long, and (5±0.2) cm wide. The leaves are orbicular, with crenate margin (80±0.5) cm long, and (70±0.5) cm wide. The above-water leaves are emerald and under the water they are marble-pink, with noticeable venation. The leaves are crimson along the edges and have sharp edges for (5±0.2) cm long, the petioles are 0.15–2 m long and have olive colour.

In nature the tuberiform plants of the *Nymphaea* genus including *N. gigantea* are

flowering and fruit bearing. They are developing in spring, during a short period of rains. The ground-based part of vegetative and generative organs die off with the end of rains and the plants spend a bigger part of the year at a tuberous condition in moist mud, like a simple ephemeroides- geophites. The renewal of leaves and roots is observed in parent tubers and child tubers and in ascending stolons only during the rain periods or when water-level is raising. During long flood periods the plants can completely die off and then in 4–5 years they can gradually be renewed from seeds [5; 14].

In conditions of protected soil of Botanical garden we have observed the conditions of ontogenesis periods of *N. gigantea*. In natural conditions of tropical rivers of Australia these periods are limited by water level abatement (from October till December) and flood (February-March). That is why seeds grow up only next year.

Periods and conditions of ontogenesis of the *N. gigantea* Hook

Latent period: Condition "seed" **(sm)** is a period of seeds ripening which is observed in spring, after 14–18 days of growing up in temperature of +18°–20°C. Such conditions for them we create in April. The type of growing up is underwater; they grow up in upper layers of soil with a depth of water layer of 5–8 cm. This condition lasts for 8–9 months.

Pregenerative period: Condition "sprout" **(pl)** – the sprouts are with awl-shaped leaf; they stay in this condition for 14 days. The condition of "juvenile plants" **(j)** is characterized by the appearance of one submerged elongated and wide spear-shaped leaf and 5–6 elongated and round leaves and bunches of 10–15 roots (this period lasts for a year). The condition of "immature plants" **(im)** – is characterized by appearance of 3–5 floating orbicular leaves with crenate margin, and their dying closer to winter. This condition is characterized by forming of an underground sprout – a circular tuber of pink-violet colour and bunches of 20–30 roots, which disappear during a relative rest period and grow back in April (this period lasts 2–3 years). The period of "virginal plant" **(v)** is characterized by continuation of forming of underground sprouts. It's also characterized by forming plant tubers, which enlarge and become a violet-brown colour. In April 5–8 elongated-circular underwater leaves appear, and in May the leaves are floating, orbicular with crenate margin which have 20–30 cm in diameter. By winter these leaves die off and an underground sprout which is a circular tuber of a pink-violet colour and a bunch of 20–30 roots are formed. They die off during a relative rest period in November and grow back in April (it lasts for 3–4 years).

Generative period: Condition of "young generative plants" (**g-$_1$**) is characterized by appearance in May of 15–25 floating orbicular with crenate margin leaves which have 80–85 sm (have 3–4 years old plants), a bunch of 50–60 roots forms. It lasts for 40–45 days after relative rest period. Condition of "middle aged plant" (**g $_2$**) is characterized by appearance of 15–25 floating orbicular with crenate margin leaves in June which have 80–85 cm in diameter and an underwater bud which starts flowering (in 15–16 days). The appearance of flowers is cyclically connected with the

appearance of a floating leaf. The plants flower for 8–9 days, from June till October. Flowering starts in the morning hours from 8 a.m. till 6–7 a.m. During a day the flowers are opened for 12–13 hours, they are closed for 10–11 hours. It was studied, that a strict cyclic recurrence between petals and anthers is absent. Fruit is bacciform. The ripening period is 20–25 days. The seed has an oval shape, with an arillus, a round top is (5±0.2) cm long, and (3±0.2) cm wide. The arillus destroys in 5–6 hours after ripening of a fruit. The spermoderm is coriaceous, longitudinal-striated. The fruit become fully ripe in 25–30 days after an artificial fertilizing of a first-day flowering flower. Weight of 1,000 seeds is 14.6–16.5 grams. One fruit contains 550–600 seeds. Seeds' mass and their quantity have a negative correlation; the mass is changes inversely to the quantity [6]. The plants stay in this condition for 5–6 months.

Condition "old generative plants" **(g-$_3$)** is determined by the end of flowering (in October-November), by gradual disappearing of floating leaves. An underground sprout (formed tubes) deepens in the thickness of soil with the help of contractile roots. Then an underground sprout and roots die off (it lasts for 6–9 weeks).

Postgenerative period: Condition "subsenile plants" (**ss)** is characterized by accumulation of nutrients in tubers, by their enlargement up to 8–10 cm in length, and 5-7 cm in width, and by change of colour to dark violet-brown (it lasts for 40–54 months). Condition "senile plants" (**s)** is characterized by formation of vertical and horizontal stoles on a parent tuber and also by formation of child tubers (it lasts for 2–3 years). Condition "dying plants" (**sc)** is observed on parent tubers which become hollow and float up to the surface of the water or rot in the thickness of soil (it lasts for 1,5–2 years).

The anatomical studies have shown that the leaves of considered species (located on the water and above the water) are epistomatous. They have stomata of anomocytic type (fig. 1A). The epidermis cells have flexuous shape and have no trichomes. The projection of the epidermal cells area is elongated. The upper epidermis is thicker than the lower one (16.66±0.3 and 18.74±4.17 μm respectively), although a cuticle and wax are almost absent on the lower epidermis. A palisade mesophyll consists of two-tree layers of cells, its thickness is 131.2±10.48 μm. It also contains large intercellular spaces filled with the air which are not typical for other species of the Nymphaea genus (fig. 1B). A spongy mesophyll is presented by aerenchyma (its thickness is 149.94±24.52 μm). Conductive tissue is developed poorly, that is typical for all aquatic plants. Mechanical tissue is represented by asterosclereids with calciumoxalate crystals frequent in cell walls of mesophyll.

In the studied plants the stomata were found only on adaxial surface of floating and above-water leaves. The stomata are absent on abaxial surface of leaves of both types. There are epidermis cells which are bigger with less sinuous cell walls. There are hydropots on abaxial surface of leaves (the water stomata with the thickened walls

are often adjacent to a large air cavity, surrounded by radially placed epidermal cells) that are involved in the process of the excretive of excess water and mineral salts. The hydropots are larger in size and they are located with less density as compared to stomata on adaxial surface (Table 1).

Table 1

Morphometric parameters of stoma and hydropot of Nymphaea gigantea Hook

	Amount of stomata pcs. / 1 mm²	Length of stomata µm	Width of stomata, µm	Amount of hydropots pcs. / 1 mm²	Length of hydropots µm	Width of hydropots, µm
Floating	337±49	23.95±1.1	21.33±1.9	90±30	31.28±3.20	29.21±2.5
Above- water	225±45*	23.14±2.4	19.5±2.3*	97±34	30.39±2	26.8±2.4*

- – P≤0,05 compared with this parameter of floating leaves.

Comparing floating and above-water leaves, it can be observed the reduction of the number of stomata per unit of area. And smaller sizes of stomata and hydropots also can be observed in above-water leaves. These parameters testify to a decrease in the necessity for excretive of excess water and mineral salts by above-water leaves.

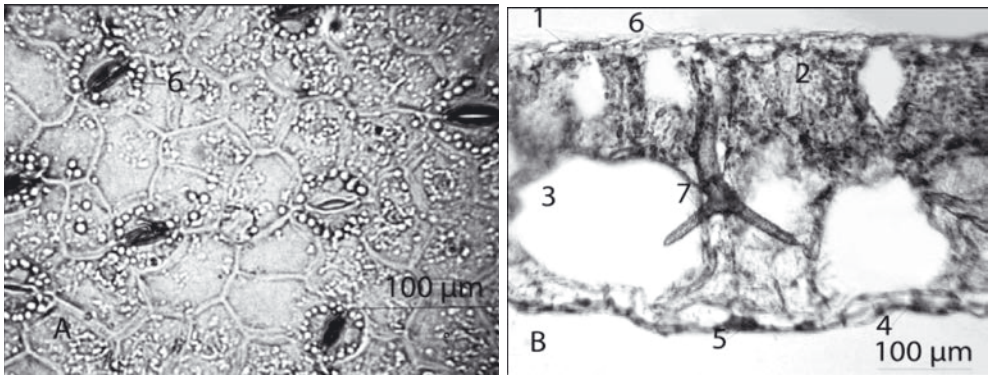


Fig. 1. Micrographs *Nymphaea gigantea* Hook.: A) upper epidermis, B) cross section of lamina:
1 – upper epidermis, 2 – palisade mesophyll, 3 – aerenchyma, 4 – lower epidermis, 5 – hydropot, 6 – stoma, 7 – asterosclereida

CONCLUSIONS

According to the complex researches the development of *N. gigantea* in greenhouse conditions continues for 8–10 years. It takes 3–4 years of development from sprouting seeds to flowering plants. After that, a phase of flowering and fruit bearing begins that lasts for 5–6 months. For the next 2–3 years the plants continue their flowering and bearing fruit. During the next two years the plants continue their flowering but less abundantly. It was established that the flower of *N. gigantea* isn't

airhaic, and its special structure proves the existence in its structure of cylinders on which the sepals, petals, anthers and a pistil are accommodated. A parent tuber dies off gradually after forming child tubers. It was proved that *N. gigantea* relates to a tuberous biomorphological structure.

It was proved that the leaves of *N. gigantea* plants have specific anatomical features except those features that are typical for the plants of *N. gigantea* genus. It was founded that except an expressed aerenhim, with single asterosclereids and hydropots on abaxial surface, there are large intercellular spaces filled with the air in a palisade mesophyll. The heterophylia is observed annually on a morphological level after a relative rest period.

BIBLIOGRAPHY

1. Бондарцев А. С. Шкала цветов / А. С. Бондарцев. – М.; Л.: Изд-во АН СССР, 1954. – 27 с.

2. Васильев А. Е. Ботаника. Анатомия и морфология растений / А. Е. Васильев, Н. С. Воронин, А. Г. Еленевский, Т. И. Серебрякова. – М.: Просвещение, 1978. – 478 с.

3. Жукова Л. А. Онтогенез и циклы воспроизведения растений / Л. А. Жукова // Журнал общества биологии. – М. – 1983. – Т. 44, № 3. – С. 361–374.

4. Кємпбел Д. Х. Ботанические ландшафты земного шара / Д. Х. Кємпбел. – М.: Иностр. литература, 1948. – 439 с.

5. Львович М. И. Єлементы водного режима рек земного шара / М. И. Львович // Тр. научн.-исслед. учреждений Гидрометслужбы. Гидрология суши. – М, 1945. – Сер. 4. – Вып. 18. – С. 244–250.

6. Мазур Т. П. Онтогенез та біоекологічні особливості Nymphaea gigantea Hook. / Т. П. Мазур // Інтродукція рослин. – К.: Наук. думка, 1999. – № 3–4. – С. 66–71.

7. Работнов Т. А. Жизненный цикл многолетних травянистых растений в луговых ценозах / Т. А. Работнов // Труды Бот. ин-та АН СССР. Сер. 3. Геоботаника. – Л., 1950. – Вып. 6. – С. 7–204.

8. Серебряков И. Г. Жизненные формы высших растений и их изучение / И. Г. Серебряков // Полевая геоботаника. – М.; Л.: Изд-во АН СССР, 1964. – Т. 3. – С. 146–208.

9. Тахтаджян А. Л. Система магнолиофитов / А. Л. Тахтаджян. – Л.: Наука, 1987. – 439 с.

10. Тахтаджян А. Л. Флористические области Земли / А. Л. Тахтаджян. – Л., 1978. – 247 с.

11. Brummitt R. K. Vascular plant families and genera / R. K. Brummitt. – London: R.B.G. Kew, 1992. – 732 p.

12. Hejný S. Über die Bedeutung der Schwankungen des Wasserspiegels for die Charakteristik der Makropyten Gesellschgaften in den mitteleuropoischen Gewassern / S. Hejný. – Preslia, 1962. – 34. – № 4. – S. 359–367.

13. *Hejný S. The dynamic characteristic of littoral vegetation with respect to changers of water level* / S. Hejný // Hydrobiologia. – Bucuresti, 1971. – 12. – P. 71–85.

14. Henkel F. Das Buch der Seerosen / F. Henkel, F. Rehnelt, L. Dittman. – Darmstadt: Garienarchitekt, 1907. – 158 s.

THE SEGREGATION OF GENERATIVE DESCENDANTS OF PERENNIAL SAVORY (SATUREJA MONTANA L.).

G. Musteatsa, C. Timciuc, Z. Vornicu, T. Jelezneac, N. Rosca, N. Baranova

Institute of Genetics, Physiology and Plants Protection of the ASM

e-mail: musteatag@gmail.com

Abstract. Productive qualities at generative and vegetative descendants of two precious perennial savory clones were studied. The descendants' degree of segregation of this species depends on genotype and generally is less significant. C_{54} clone is the most productive, ensures equal production at generative and vegetative descendants of about 10t/ha of raw material, 52.1 and 56.0 kg/ha of volatile oil, respectively.

Key words: savory, generative descendants, raw material, volatile oil.

INTRODUCTION

Perennial savory, known also as mountainous savory (*Satureja montana* L.*)* – aromatic, medicinal and perspective species is on the way of implementation on the industrial areas. Raw material, herb in fresh state, is used in essential oil production, is requested in the pharmaceutical industry also in perfumery and cosmetics production [1, 2, 4 and 8]. Mountainous savory volatile oil and herb displayed to be a replacer of black pepper, as a condiment in sausage production [5]. Mountainous savory is an excellent replacer of culture thyme; herb of this cultivated species as a component of many dietary supplements that are produced in Moldova, including „Doctor Farm" Company is included [1]. Being a perspective species, a highly productive and quality sort named Alpha-14 was created that gives in the harvest years an average production of 9.0 t/ha raw material and 54 kg/ha of essential oil which possess phenolic compounds (carvacrol+thymol) 81% content [7]. One of the problems for implementation of this species on the industrial areas is the lack of cheap and quality propagating material.

Being an allogamous species, we can recommend it to be multiplied vegetatively by cuttings, by layers or bushes fragments [1, 4 and 8]. The production by the methods of rooting, lignified shoots fragments and green cuttings is expensive. Mountainous savory is multiplied more easily by seed. Some researchers attested that at the

mountainous savory, having a long flowering period, the autogamous phenomenon in some forms persists, so it can be successfully reproduced generatively [6, 9]. It was also established that the cuttings and layers well rooted as planting material have equal productive qualities [6].

Based on above-mentioned and in connection with the selection of clones with high content of volatile oil, productive qualities of generative and vegetative descendants of perspective clones, for argument's recommendations concerning acceptable methods of its multiplication were studied.

MATERIALS AND METHODS

The investigations with selected clones C_{70} and C_{54}, with the seedlings obtained from seeds of done clones, the sowing of the seeds directly in the field, having as a control the seedlings of mid-early ameliorate population were performed. In the research, the following variants were tested: V_1 – planted plantation with one year lignified seedlings of mid-early quality improved population – control; V_2 – planted plantation with well rooted layers class one of clone C_{70}; V_3 – planted plantation with seedlings of 40-45 days from seed clone C_{70}; V_4 – planted plantation with first class layers clone C_{54}; V_5 – planted plantation with seedlings from seeds clone C_{54}; V_6 – plantation initiated by seeds sowing directly in the field, the seed clone C_{70}+C_{54} (1:1), the norm 2.0 kg/ha.

The experience was mounted in spring (15-16 March 2009); row spacing is 70 cm, spacing between plants in the row-70 cm, 20 000 plants /ha were planted, by 24 bushes in each plot, 4 repetitions. The plant care system each year includes 2-3 cultivations between the rows and, if necessary manual hoeing in rows must be done (3-4 per season), by ensuring the plantation in the state free of weeds, herbicides to control weeds were not used. In the first year of vegetation in July plant peaks were removed at the height of 10-12 cm, for ensuring bushes formation. At the end of the vegetation in October-November the black patches of land were filled. Starting with the second year of vegetation, all the variants were fertilized in early spring with nitrogen (ammonium saltpeter) N_{60} in dose. The first harvest in the second year of vegetation (2010) was obtained. The harvesting was done manually, with the sickle, in full flowering period, cutting the leafy part of annual shoots with inflorescences. Before and at harvest moment raw material for determining volatile oil content after Ginzberg were sampled [10]. Interpretation of the statistical analysis of variance was performed according to the method Dospehov [11]. After thermal and pluviometric regime the years of research have been different. The agricultural years 2008-2009 and 2011-2012 were dry, and the years 2010, 2011 and 2013 had a nearly normal, favorable hydric regime. In all the years, the average air temperatures, throughout all the months of active growth (April-August) have exceeded the norm by 0.6 to 3.80°C.

RESULTS AND DISCUSSIONS

In the spring of 2009 (in March) the abundant and atmospheric rainfall were uniformly distributed, which favored the seed emergence of V_6. The seedling of 40-45 days in variants V_3 and V_5, being planted with abundant irrigation, also stroke roots at 95-98%. Clone C_{70} layers stroke roots by 8-10% less than those of clone C_{54}, which were rooted at 95-96%. In autumn all the black patches of land were filled with suitable seedlings well rooted, so in the second year of vegetation the density at 99% corresponds to the norm. On the background of pluviometric favorable regime, the plants in all variants of the second year of vegetation have strongly developed, forming bushes with a harvest average 39-41cm height and 58-60 cm in diameter. The length of annual shoots in full flowering stage is 29.5 cm in the control group, and 30-35 from the layers plants. Studied variants essentially differ by the number of annual developed shoots, 339 units/m^2 at the control, 264 - in the variant planted with clone C_{70} layers and 416 units/m^2 in the variant planted with clone C_{54} layers. Seedling bushes produced by seed form more vigorous shoots from clones C_{70} and C_{54}, the mass at 25 developed shoots constitutes 62.9 g in the control group, but 67.1 g and 72.2 g from clone C_{70} seedling. According to the productivity values, the production at mountainous savory, in all variants studied and in all the years of research was sufficiently high, more than 7 t/ha (Table 1). In the second year of vegetation (the first year of harvest – 2010) in the control variant fresh raw material production was 7.7 t/ha. Highest yield per 12.1 t/ha of raw material from the sowing plantation directly in field was obtained and attested with 57% more than in the control group. In other variants the production in the first harvest year showed at control group level. The planted plantation with layers of clone C_{70} had a somewhat lower yield (6.45 t/ha), but the deviation from the control group isn't significant. In the present research the high drought resistance to mountainous savory was established, which in droughty 2012 year productions of 7.1 t/ha in the control group was realized, 9.6 t/ha on the planted plantation with clone C_{54} layers and 10.3 t/ha in the sown field.

Table 1

Production of raw materials at perennial savory, according to the method of initiating the plantation (2010-2013)

Propagating material for initiation of the plantation	Production of fresh raw material, t/ha						
	years of vegetation				average		
	2010- II	2011 - III	2012 - IV	2013 - V	t/ha	±	%
V_1 - 1 year seedlings of mid-early population-control	*7,67*	*7,30*	*7,14*	*11,58*	*8,42*	*-*	*100*
V_2 – layers selected bushes of clone C_{70}	*6,45*	*7,10*	*7,66*	*10,41*	*7,91*	*-0,51*	*94*

V_3 – seedlings from seeds of cloneC_{70}	*7,92*	*6,80*	*6,97*	*12,53*	*8,55*	*0,13*	*102*
V_4 – layers selected of clone C_{54}	*7,64*	*9,20*	*9,64*	*14,10*	*10,15*	*1,73*	*121*
V_5 – seedlings from seeds of clone C_{54}	*7,84*	*10,30*	*8,11*	*13,63*	*9,97*	*1,55*	*118*
V_6 – sowing directly in field of seeds clone $C_{70} + C_{54}$	*12,12*	*15,80*	*10,26*	*13,42*	*12,90*	*4,18*	*153*
DL_{05}	*1,5*	*0,9*	*1,56*	*1,88*			

The highest production of fresh feed was obtained in the fourth year of harvest (2013) which was very favorable after pluviometric and thermal regime. In the conditions of this year in the control variant was achieved the production of 11.6 t/ha, at selected layers C_{54} – 14.1 t/ha, and in the plantation initiated by sowing directly in field – 12.9 t/ha. On the average for 4 years of harvest, the production at the control constitutes 8.4t/ha. The highest production of aromatic raw materials was realized by directly sowing in the field, 12.9 t/ha, i. e. with 54% exceeding the control group. But this variant is difficult to reproduce in the conditions of production, convenient conditions happen once in 10 years. However without that is impossible to obtain a sufficient and uniform generation of mountainous savory in field conditions that requires superficial incorporating (from 1.0 – 1.5 cm) of seeds. The other studied variants ensure stable uniform density of plants in plantation and easily can be reproduced in production conditions. Out of these, the highest harvest was attested at the plantation planted with clone C_{54} layers with seedlings from the seeds of above-mentioned clone of 10.2 and 10t/ha, respectively. The clone C_{70} and its generative descendants have realized equal production to the control. Generative descendants of both clones have not at negative segregation concerning size the harvest of raw material. Volatile oil content of raw material at control group during the years of investigation varied between the limits of 0.443 (2010) – 0.589% (2012). The improved population at control reproduced by generative way registered an average content of 0.513% volatile oil. The clones C_{70} and C_{54} have exceeded the control variant and registered a volatile oil content of 0.577 and 0.547% (Table 2).

Table 2

Production of volatile oil at perennial savory, depending on the mode of initiating the plantation (2010-2013)

Variants: propagation material used for initiating the plantation	Volatile oil in fresh raw material, % (average 2010-2013)	Production of volatile oil at perennial savory, depending on the mode of initiating the plantation					
		years				average	
		2010	2011	2012	2013	kg/ha	%
V_1- 1 year seedlings from the seeds of improved population-control	*0,513*	*34,1*	*36,9*	*42,1*	*59,4*	*43,1*	*100*
V_2 - layers of selected clone C_{70}	*0,577*	*29,1*	*41,6*	*52,2*	*60,7*	*45,9*	*107*

V_3 - 1 year seedlings from the seeds of clone C_{70}	*0,534*	*33,3*	*38,5*	*42,4*	*67,2*	*45,8*	*106*
V_4 - layers of selected clone C_{54}	*0,547*	*35,6*	*45,4*	*64,0*	*78,8*	*56,0*	*130*
V_5 - 1 year seedlings from the seeds of clone C_{54}	*0,524*	*34,1*	*49,3*	*52,0*	*73,1*	*52,1*	*121*
V_6 – sowing directly in field of seeds clone C_{70} + C_{54}	*0,507*	*57,7*	*73,7*	*58,9*	*68,8*	*64,8*	*150*

Generative descendants from both clones volatile oil in raw material with 5-8% lower than the mother clones have been registered, thus showing a slight negative segregation. The production of volatile oil in control on average per four years was 43.1 kg/ha. The clone C_{54} which achieved an average of 56.0 kg/ha exceeding the control by 30% is more productive. The clone C_{70} has less productive qualities, exceeding the control after volatile oil production by only 7%. The production of the generative descendants of clone C_{70} was equal to that of mother plantation realized, whereas at the clone C_{54}, the seed seedling, was less productive by 9%. The highest production was obtained from the plantation initiated by sowing directly in the field – 64.8 kg/ha volatile oil (150% from control), but this variant is difficult to reproduce in the open field. The data obtained in this variant clearly justifies that such high yields from generative descendants on the sowing directly in field are obtained due to higher density of the plants, in comparison with the other variants. This advantage is more pronounced during the first 2-3 years of harvest, until the bushes in the control and in the other variants increase in diameter, but while it branches the number of stems skeleton and the productivity of bushes increases. Generally mountainous savory generative descendants segregate unequivocal concerning the productive peculiarities of different clones. In all clones, more or less, generative descendants have a content of volatile oil in raw material more reduced comparatively to mother plant. After production, segregation of generative descendants at the clone C_{70} is less than at the mother plant. Generally the segregation of generative descendants at mountainous savory is insignificant, which induces the supposition of autogamy presence in this species. This, in its turn, confirms to us the possibility of admitting without loss of the reproduction on generative way of mountainous savory (by seedlings) for industrial productions of clones C_{70} and C_{54}.

CONCLUSIONS

1. From the selected perennial savory plants, a more productive clone C_{54} was emphasized, where the average of raw material productions, during 4 years, of 10.2 t/ha, and 56.0 kg/ha of volatile oil was realized, exceeding the control with 21 and 30%, respectively.

2. Generative descendants of investigated clones insignificantly segregate on the character of productivity, comparatively with the clone's mother which indirectly confirms the presence of autogamy, parallel with allogamy in this species. The generative descendants of highly productive clones (C_{54}) maintain these qualities at 95-99%.

3. The highly productive cultivars and clones (C_{54}, C_{70}) can be propagated by generative way, obtaining ligniferous cuttings or qualitative seedling for initiating industrial plantations. The seeds provided for generative reproduction are obtained on the seeding plots isolated in space from industrial plantations.

4. The generative descendants of perennial savory negatively segregate concerning the volatile oil in raw material (5%-9%) and inessential on the raw material yield.

BIBLIOGRAPHY

1. Musteaţă G., Jelezneac T., Timciuc C. ş.a. Metode de producere a materialului săditor de cimbru de munte (*Satureja montana* L.). În: Biotehnologii avansate – realizări şi perspective al III-lea Simpozion naţional cu participare internaţională: Teze. Chişinău: S.n., 2013. P. 120.

2. Diug E., Prisacaru V., Bodrug M. The elaboration of the medicine with antiseptic action based o volatile oil. În: Plante medicinale – realizări şi perspective: Simpozion naţional, Ed. IV. Piatra Neamţ, 1994. P. 92-93.

3. Дудченко Л. Ароматы здоровья // Эфиромасличные растения в аромотерапии. Киев: Глобус, 1997. 146 с.

4. Машанов В.И., Андреева Н.Ф., Машанова Т.С., Логвиненко И.Е. Новые эфиромасличные культуры. Симферополь: Таврия, 1988. 160 с.

5. Шукюров Н., Алиев К., Шляпникова А., Мустяцэ Г. Эфирные масла пряных культур как вкусоароматизаторы мясных и молочных продуктов //Основные направления научных исследований по интенсификации эфиромасличного производства. Часть 2. Симферополь, 1985. С. 34-35.

6. Musteaţă G.., Roşca Nina., Timciuc C., Baranova Natalia. Creşterea, dezvoltarea şi productivitatea cimbrului de munte (*Satureja montana* L.). În funcţie de calitatea materialului săditor. În: Mediul ambiant. 2010. Nr. 5 (53). P. 27-30.

7. Тимчук К.С., Железняк, Тамара Г., Ворнику Зинаида Н., Мустяцэ Г.И. Новый сорт чаберагорного *(Satureja montana* L.*)* Alfa-14. În: „Новые и нетрадиционные растения и перспективы их использования": Материалы X Международного симпозиума. Т. 2. Москва, 2013. С. 140-143.

8. Musteaţă G.I. Cultivarea plantelor aromatice. Chişinău: Cartea Moldovenească, 1980. 240 p.

9. Musteaţă G.I. Cimbru de munte – *Satureja montana* L. (sistematica, biologie, cultivare, utilizare). Chişinău: Tip. UASM, 1999. 48 p.

10. Гинзберг А.С. Упрощенный способ определения количества эфирного масла в эфироносах. În: Химико-фармацевтическая промышленность. 1932. № 8-9. С. 326-329.

11. Доспехов Б.А. Методика полевого опыта. Москва: Колос, 1979. 416 с.

PECULIARITIES OF PROPAGATING THE *PRINSEPIA SINENSIS* (OLIV.) KOM SPECIES

A. Palancean, Elisaveta Onica, I. Roşca
Botanical Garden (Institute) of ASM
18, Pădurii, str., MD-2002, Republic of Moldova

INTRODUCTION

In relation to climate changing, hazardous degradation processes of vegetation, and worsening the conditions for existence of plant species have been identified – for this reason, it is need, to mobilize and preserve the biodiversity within continuity. Architectural gardening in urban localities and rural areas has a landscape, sanogenous, and economic competence. For landscape gardening of decorative and qualitative planting material is needed, more superior to the existing one, with early flowering period and long duration. For this reason the *P. sinensis* species study of propagating peculiarities has been proposed, having the target of its cultivation and implementation in landscape gardening.

MATERIALS AND METHODS

P. sinensis species served as biological experimental material. It is a deciduous dense shrub with arching spiny branches. In spring, it brings yellow flowers. Possess red cherry-like fruit. Plants prefer well-drained soil and full sun, they are extremely hardy and drought tolerant. They can be used as hedge.

RESULTS AND DISCUSSIONS

P. sinensis represents an attractive and durable large spiny shrub, its peculiarities are soft yellow flowers in spring and showy oblong red berries in fall; arching and sprawling habit of growth, spiny branches, makes a great low maintenance barrier plant; grows in full sun. Cherry Prinsepia has emerald green foliage throughout the season. The narrow leaves turn yellow in fall. It has racemes of yellow flowers along the branches in early spring. The fruits are showy red drupes carried in abundance from midsummer to early fall. The peeling brown bark is not particularly outstanding.

Cherry Prinsepia is a dense multi-stemmed deciduous shrub with a more or less rounded form. Its relatively fine texture sets it apart from other landscape plants with less refined foliage.

This is a relatively low maintenance shrub, and is best pruned in late winter once the threat of extreme cold has passed. It is a good choice for attracting birds to your yard. Gardeners should be aware of the following characteristics that may warrant special consideration. Cherry Prinsepia is recommended for the following landscape applications; Mass Planting, Hedges/Screening, General Garden Use. Prinsepia is not a common shrub but is worth considering for hedges, screens, or as a specimen plant in the back of a garden. The endearing trait of being the first shrub to trust its green leaves upon the spring landscape makes it worth wile considering; no one characteristic is particularly outstanding but the sum of all the parts equals a good, serviceable shrub that could be utilized effectively on difficult sites.

Yellow Prinsepia flourishes early, at the same time as foliage, when during 10 days the air temperature is more than 5^{o} C. Fruits are maturing in September-October. Freshly peeled seeds were selected in three groups as follows: a part of seeds for preserving and stratifying, the second one – 48 hours in distilled water, the third – exposed in 0,01mg/l de $KMnO_4$ solution. The treated seeds were incorporated into the soil well loosened, in open ground, in late October. It was established that treated seeds have higher germination (75%) than untreated (50%). The stratified seeds over 150-180 days at the temperature 0-5° C and sown in spring had lower germination (30-45%). The seed germination percentage depends on the period of incorporation in soil and of the climate conditions in which the mother plants were developed. The seeds harvested in the droughty 2012 had a germination of 20%. The plantlets obtained from seeds possess a radicular system well developed.

Prinsepia is propagated by ligniferous cuttings, sampled in late fall or in early spring and conserved in refrigerators or cold seedbeds in plastic bags. The cuttings are taken from the middle of annual shoots, then in cold seedbeds are planted. The optimal variant for obtaining planting material with minimal costs is that of woody cuttings treatment with solutions of 0.01% heteroauxin for 16 hours and planted in cold seedbeds in late spring, avoiding the danger of spring low temperatures has been established. The rhizogenesis percentage of woody cuttings depends on climatic conditions and of technology throughout the period of vegetation. The plantlets obtained from seeds and seedlings in containerized conditions and well prepared soil were planted.

CONCLUSIONS

P. sinensis is propagated by generative and vegetative way and can be successfully implemented in landscaping. It was established that *P. sinensis* species

seeds germination percentage depends on many objective and subjective factors. A decisive role belongs to the climatic conditions during flowering and growth periods, also of fruits maturation, seed quality, seed conservation conditions, substrate or the germinating bed where the seeds were incorporated, accept the technology during the whole period of vegetation – from the incorporation of the seeds in necessary substratum, until transplanting seedlings in the open field.

BIBLIOGRAPHY

1. Palancean A., Comanici I. Dendrologie (Asortimentul de arbori, arbuşti şi liane pentru împăduriri şi spaţii verzi). Chişinău: F.E.-P: „Tipogr. Centrală". 519 p.

2. Palancean A.I. Reproducerea speciilor lemnoase (Lucrare metodică). Chişinău. 2000. 48 p.

SOME BIOLOGICAL PECULIARITIES AND VALUE OF THE FORAGE OF ASTRAGALUS PONTICUS PALL

Alexandru Teleuţă, Victor Ţîţei

Botanical Garden (Institute) of the Academy of Sciences of Moldova, 18 Pădurii str., MD-2002 Chişinău e-mail: director@gb.asm.md

Abstract: In the context of the reduction of the acute deficit of protein, it is necessary to extend the areas with crops rich in protein, such as those of the family *Fabaceae* Lindl. The *Astragalus ponticus* Pall. plants, from the collection of nontraditional fodder plants of the Botanical Garden (Institute) of ASM, maintained in pure culture, served as object of study. As a result of the conducted researches, it was established that in order to germinate abundantly the seeds of *A. ponticus* needed to be scarified and that in the first year of vegetation they had a slow growth and development. In the following years, A.ponticus plants started to grow 5 days later than *Medicago sativa* L., the flowering period started simultaneously and the seeds' ripening 26 days earlier. The seed production of A. *ponticus* in the conditions of Moldova constituted 40.90 g/m2 (27.14 g/m^2 of the *M.sativa*). The maximum accumulation of green mass at *A. ponticus* occurred during the budding stage and the harvest constituted 1.48kg/m^2, with a high content of dry matter. 1 kg of natural fodder contained 63.84 g raw protein, 47.27 g digestible protein and 7.90 g fats, compared with 46.10 g, 34.50 g and 20.0 g of the alfalfa. The natural fodder of *A. ponticus* had a high content of essential amino acids such as threonine, valine, isoleucine, lysine and a low content of methionine, phenylalanine and arginine. It was also rich in carotene, vitamin C, in minerals, especially phosphorus (1.23 g/kg natural fodder compared with 0.54 g/kg in the control variant *M. sativa*) and had a high content of digestible protein 225.09 g/nutritive unit (164.29 g of the *M. sativa*).

Key words: *Astragalus ponticus,* biological peculiarities, productivity, biochemical composition, nutritional value, amino acids.

INTRODUCTION

In the context of the acute shortage of protein in the food of humans and animals [3], it is required the expansion of areas where protein crops are cultivated by mobilizing new species that would extend the assortment of both: cultures for the production of food for humans and the fodder necessary for the development of the animal husbandry sector, poultry farming and pisciculture. For the exploitation of eroded lands, which extended in the recent years, the species of the family *Fabaceae* Lindi are of particular interest. Because of the assimilation and storage of nitrogen in soil (up to 100 kg N/ha per year) these species can contribute to reducing emissions of greenhouse gases and the perennial fodder leguminous grasses contribute to halting erosion, improving the soil structure and reducing its acidification, increasing the

favourable biodiversity for pollination, having an important role in enhancing the productivity and the quality of fodder, both collected from pastures and meadows and in pure culture, heightening the nutritional value of the obtained production.

It is well known that the productivity of the grasslands from the Republic of Moldova is very low, constituting 300 - 500 kg/ha of hay, and the share of fodder leguminous plants is decreasing [7]. The fodder leguminous grasses play an important role in increasing the quality of feed, due to a significant contribution in protein, vitamins and minerals, which raise the nutritional value of the feed and the livestock production [1, 5]. The genus *Astragalus* L. comprises approx. 2,500 species and is the largest genus of angiosperms [4, 6]. In the spontaneous flora of the Republic of Moldova are 16 species [6], from these species, *Astragalus cicer* L. and *Astragalus ponticus* Pall possess a certain forage value. The green mass of these species, used fresh, do not cause bloat at ruminant animals. *Astragalus ponticus* Pall. one of them are rare species in Moldova, Ukraine, Russia [10,12]. In order to redress the situation regarding the increase of the productivity and the quality of fodder, it is necessary to extend the range of fodder leguminous species and to carry out reseeding works. One of the causes of the reduced use of the representatives of the genus *Astragalus* L. as feed for animals is the insufficient knowledge of the biological characteristics of these species, the biochemical composition of these plants and their fodder value [1]. These aspects have determined the choice of the object of study.

The Botanical Garden (Institute) of A.S.M.'s collection of non traditional fodder plants counts near 280 species and varieties, inclusive 68 leguminous. Scientific investigations performed in the last 60 years have been focused on improving and implementing new species, and new forms and varieties, and cultivation technologies have been developed [9,15].

MATERIALS AND METHODS

The *Astragalus ponticus* Pall. plants, from the collection of non traditional fodder plants of the Botanical Garden (Institute) of A.S.M, maintained in pure culture, served as object of study. This species is widespread in the wild flora of Romania and Republic of Moldova. *Medicago sativa* L., *Trifolium repens* L. and *Lotus corniculatus* L. served as control variant. Foundation of experiments was performed with previously scarified seeds of *A. ponticus* on chernozem usual in spring when the soil had reached the physical maturity. The seeds were planted at a depth of 1.5-2.0 cm, with soil compaction before and after sowing. The evidence area of the plot constituted 10 m^2. The number of repetitions – 4. The scientific researches on growth and development, productivity and nutritional value of the plants were carried out according to the methodical indications [11, 13, 14].

RESULTS AND DISCUSSIONS

As a result of the performed researches, it has been established that, in order to germinate abundantly, the seeds of *Astragalus ponticus* Pall. need to be scarified [16]. In the first year of vegetation, these species, in comparison with *Medicago sativa* L., *Trifolium repens* L. and *Lotus corniculatus* L., have a slow growth and development, reaching only the step of forming of the stem with leaves. At the end of the first year of vegetation the plants reach 12-16 cm tall.

In the following years, the growth and development of plants of *A. ponticus* (Table 1) begins when positive temperatures are established, in the second half of March, 4-7 days later compared to other species. The growth rate of this species, in the first 20 days of vegetation, is faster in comparison with *T. repens* and *L. corniculatus* reaching 27.2 cm, but it is slower in comparison with *M. sativa*. This tendency is maintained during the vegetation, so, in the flowering period, the plants of *A. ponticus* reach 76 cm tall (Fig. 1). It can be mentioned that the flower buds formation and the flowering of the studied species starts around the same time, also, from the restart of vegetation this period constitutes at *A. ponticus* – 66-77 days and 75-82 days at *M. sativa*.

Fig. 1. Astragalus ponticus Pall

A. ponticus plants are characterized by a shorter period of seed formation and ripening. So, the period "beginning of vegetation – seed ripening" at *A. ponticus* constitutes 117 days compared with 143 days at *M. sativa.*

The seed production is a key pillar in the capacity of maintenance and expansion of the species. Analyzing the data presented in the Table 2, we could mention that a high production of seeds has been found at the species *A. ponticus* (about 40.9 g/m^2), but because the seeds are big, this species forms the lowest number of seeds per unit

of area. A larger quantity of seeds is formed at the species *T. repens* (27 thousand / m^2), and *L. corniculatus* (21 thousand / m^2).

Table 1

Biological peculiarities of the studied species of the family *Fabaceae*

Indicators	Astragalus ponticus Pall.	Medicago sativa L.	Trifolium repens L.	Lotus corniculatus L.
Beginning of vegetation	17.03	12.03	10.03	13.03
The period, days from the beginning of vegetation up to:				
- budding	66	75	71	63
- flowering	77	82	82	77
- seed ripening	117	143	119	121
Plant height, cm				
- at 20 days of vegetation	27.2	38.1	22.0	26.7
- at flowering	76.0	83.2	31.3	42.3

The yield of green mass is a totalizing indicator of the value of the fodder species [1].

At the first mowing, in the period of flower buds formation – flowering, the fresh mass yield of *A. ponticus* constitutes 1.48 kg/m^2 exceeding by far the *T. repens* plants. By a higher yield of fodder, the species *M. sativa* and *L. corniculatus* stand out. It is known that the correlation "leaves – stem" influences the nutritional value of the fodder. The natural fodder of *A.ponticus* is characterized by the highest content of leaves (56%) and the lowest (41-42 %) – *T. repens* and *M. sativa*.

Table 2

Yield of the studied species of the family *Fabaceae*

Indicators	Astragalus ponticus Pall	Medicago sativa L.	Trifolium repens L.	Lotus corniculatus L.
The yield:				
- fresh mass 1-st cut , kg/m^2	1.48	1.67	0.83	1.58
- dry matter, kg/m^2	0.40	0.44	0.28	0.55
The leaf share of the fodder, %	56	42	41	49
Seed production, g/m^2	40.90	27.14	19.12	22.30
The weight of 1000 seeds, g	8.44	2.67	0.71	1.05

Animals, in order to maintain their vital functions and to give different productions, need permanently an exogenous source of nutrients which they receive from the feed and after the process of digestion and assimilation are used by their body to provide the following functions: plastic, energetic and biocatalytic. Proteins are very important nutritive substances which provide a source of assimilable nitrogen

for the body [1]. Analyzing the biochemical composition of the natural fodder of the studied species (Table 3), we find that *A. ponticus* is distinguished by a very high content of raw protein (63.84 g/kg) that is 67-75% higher compared to the species *T. repens* and *L. corniculatus*. A high capacity of nitrogen accumulation by the species *A. ponticus* is also mentioned in other papers [2].

Table 3

Biochemical composition and nutritional value of the natural fodder

Indicators	Astragalus ponticus Pall.	Medicago sativa L. (control)	Trifolium repens L.	Lotus corniculatus L.
1 kg of natural fodder contains:				
nutritive units	0.21	0.21	0.20	0.25
metabolizable energy for cattle, MJ/kg	2.43	2.28	3.03	3.07
dry matter, g	272.40	263.70	335.00	346.70
raw protein, g	63.84	46.10	38.11	36.40
digestible protein, g	47.27	34.50	28.96	26.57
raw fats, g	7.90	6.20	7.04	11.09
raw cellulose, g	86.90	80.30	140.70	99.16
nitrogen free extractive substances, g	87.61	99.30	128.38	168.50
mineral substances, g	26.15	21.70	20.77	31.55
calcium, g	2.34	4.61	4.56	4.85
phosphorus, g	1.23	0.54	0.84	0.76
carotene, g	17,0	14,0	6,0	10,0
vitamina C, mg/%	310,0	172,0	149,6	122,4
digestible protein, *g/ nutritive unit*	225.09	164.29	144.80	106.28

It can be mentioned that the natural fodder of *A. ponticus* has a higher content of dry matter: protein, fat and cellulose compared with *M. sativa*. The species *T. repens* and L. *corniculatus* are characterized by the highest level of accumulation of dry matter, especially of cellulose and nitrogen free extractive substances, in the natural fodder that have contributed to the growth of the level of accumulation of metabolisable energy for cattle (3.03-3.07 MJ/kg).

The mineral substances in the animal feed contribute to the growth and health of animals, because they are essential components of all the tissues and organs that maintain at a constant level the osmotic pressure, participate in the regulation of acid-base balance, activate a number of enzymes, moderate the neuromuscular activities, prevent the occurrence and development of some diseases of animals [8]. L. *corniculatus* and *A. ponticus* have a high content of minerals in the natural fodder. It can be mentioned that, *A. ponticus* has lower calcium content in fodder, but it has the highest level of phosphorus – 1.23 g/kg.

The natural fodder of the studied species is differs by the content of some vitamins (carotene, vitamin C). After the carotene content in natural fodder, the species

A. ponticus exceeds 1.9 to 2.8 times the species *L. corniculatus* and *T. repens,* but the content of vitamin C exceeding all investigated species.

The natural fodder of the studied species is ensured, according to the zootechnical standards, with digestible protein, the highest content being in the fodder of *A. ponticus* (225.09 grams per nutritive unit) or 37% more than *M. sativa*, 56% – *T. repens* and 118% – L. *corniculatus*.

Table 4

The content of amino acids in the fodder (mg/100mg dry matter)

Amino acids	Astragalus ponticus Pall.	Medicago sativa L.	Trifolium repens L.	Lotus corniculatus L.
asparagine	3,110	1.711	1.593	1.129
threonine	0,678	0,564	0.559	0.633
serine	0,767	0,687	0.663	0,767
glutamine	1,953	1,360	1.381	0.941
proline	0,765	0,922	1.062	0.355
glycine	0,676	0,550	0.613	0.477
alanine	0,570	0,674	0.665	0.607
valine	0,649	0,559	0.621	0.369
methionine	0,058	0,139	0.052	0,117
isoleucine	0,510	0,459	0.453	0.315
leucine	0,914	0,913	0.929	0.816
tyrosine	0,458	0,458	0.517	0.319
phenylalanine	0,794	0,850	0.806	0.416
histidine	0,411	0,326	0.364	0.136
lysine	0,760	0,619	0.658	0,517
arginine	0,306	0,655	0.584	0.402

The nutritional value of the fodder is determined by the content of certain amino acids that ensure the biological value of protein. It can be mentioned that, in comparison with the studied species (Table 4), the fodder of *A. ponticus* is characterized by a higher content of amino acids. Analyzing the content of each essential amino acid, we have found that at *A. ponticus* the content of threonine, valine, isoleucine, leucine, histidine and lysine is higher, but the content of methionine is lower (2.0-2.4 times) compared with *L. corniculatus* and *M. sativa.*

CONCLUSIONS

The fodder obtained from *Astragalus ponticus* Pall. is valuable: rich in protein, essential amino acids, fats and a high level of vitamins, mineral substances, special phosphorus.

The obtained results are a good reason for further research on the peculiarities of growth and development of *A. ponticus* in different phytocenosis.

BIBLIOGRAPHY

1. Bahcivanji, M., Coşman, S., Carauş, S., Coşman, V. 2012. Caracteristica şi valorificarea raţională a plantelor furajere naturale şi cultivate. Edit. Ştiinţa. Chişinău.

2. Davis, A. M. 1982. Nitrogen production by selected Astragalus species. Agronomy Journal 74(3): 454-456.

3. European Parliament resolution of 8 March 2011 on the EU protein deficit: what solution for a long-standing problem? (2010/2111(INI)). 2012. Official Journal of the European Union C 199 E/07: 59-68.

4. Lock J. M., and Schrire B. D., 2005. Galegeae. In: Lewis G. Schrire, B. Mackinder B., Lock J. M. (Eds.) Legumes of the World. Surrey, Richmond, 475-487.

5. Lüscher A., Mueller-Harvey I., Soussana J.F., Rees R.M., Peyraud J.L., 2013 Potential of legume-based grassland-livestock systems in Europe. Grassland Science in Europe, 18: 3-29.

6. Negru A., 2007. Determinator de plante din flora Republicii Moldova. Universul. Chişinău.

7. Starea mediului în Republica Moldova în 2007-2010. Raport National. 2011. Edit. Ştiinţa. Chişinău.

8. Suttle N. F., 2010. Mineral nutrition of livestock. 4th Revised edition. CABI Publishing, United Kingdom.

9. Teleuţă, A. 2010. Introducerea şi studierea plantelor furajere netradiţionale: realizări şi perspective. In. Conservarea diversităţii plantelor. Edit. Ştiinţa. Chişinău, 425-432.

10. Titica, G. 2013 Rare plant species of semi-desert steppes in southern Moldova. Rev. Bot., V, 2(7):27- 33

11. Ермаков А. И., Арасимович В. В., Ярош Н. Б.1987. Методы биохимического исследования растений. Агропромиздат. Ленинград.

12. Кучеревский В. В., Баранец Н. А., Сиренко Т. В., Шоль Г. Н., Демина О. Н., Рогаль Л. Л. Редкий вид флоры восточной Европы Astragalus ponticus Pall.: особенности хорологии и эколого-ценотической приуроченности. 2013. Живые и биокосные системы, 4. http://www.jbks.ru/archive/issue-4/article-12

13. Новоселов Ю. К., Харьков Г. Д., Шеховцова Н. С. 1983. Методические указания по проведению полевых опытов с кормовыми культурами. ВНИИК. Москва.

14. Петухов Е.А., Бессарабова Р.Ф., Холенева Л.Д., Антонова О.А. 1989. Зоотехнический анализ кормов. Агропромиздат. Москва.

15. Телеуцэ, А.С., Цыцей, В.Г. 2012. Нетрадиционные растения семейство бобовых – кормовые достойнство и продуктивность в условиях Республики Молдова. Таврійський науковий вісник, 80 (2): 338-342.

16. ГОСТ 28636-90. Межгосударственный стандарт семена малораспространенных кормовых культур. Сортовые и посевные качества. Seeds of little-spread forage crops. Varietal and sowing characteristics. Specifications. http://www. docs.cntd.ru/document/gost-28636-90.

BIOLOGICAL PECULIARITIES OF *ASTRANTIA MAJOR* L. UNDER *EX SITU* CONDITIONS

S. P. Torchyk, V. V. Titok

Central Botanical Garden of National Academy of Sciences of Belarus

Abstract. The research results of growth and development of *Astrantia major* L. under ex situ conditions are summarized, methods of seed and vegetative reproduction, the experience of creating artificial cenopopulation species are given in the article.

Key words: biological peculiarities, ex situ conditions.

INTRODUCTION

Increasing influence of anthropogenic factors on natural ecosystems leads to destabilization of their structure and reduction of plant species structure. As a result, some species have become rare or totally disappear. Regularities identified during the research of rare species under *ex situ* conditions, allow developing of methodological approaches to restore their natural populations.

Astrantia major L. is one such species. The risk of extinction of this species on the territory of the republic is defined by category I (CR). At the moment, the National Park "Belovezhskaya Pushcha" and Volkovysskii district of Grodno region [1] are authentically known as two natural habitats of *Astrantia major* L. Moreover, previously there were four separate habitats in the National Park "Belovezhskaya Pushcha", then in accordance with the inventory of 2006-2010 – only one [2]. In this regard, the aim of the research was to identify the characteristics of growth and development of the species under culture conditions and development of measures for its reproduction and recruitment.

MATERIALS AND METHODS

Objects of study were plants of *Astrantia major* L., entered into the reproductive phase of development and growing in the Central Botanical Garden of NAS of Belarus (Minsk). Seasonal rhythm of development was studied in accordance with methods of I.D.Yurkevich [3]. Laboratory germination was determined by seed germination at 10ºC and 24ºC. Dirt germination was determined by seed sowing in the open ground in

March, April, August and October. The dry seeds and seeds that have passed 2-month stratification in moist sand at T 0 – +5ºC were used in experiments.

Plants grown in the nursery of introduction of the CBG, which were planted using square-cluster method in the natural flora of Belarus, were used to create artificial cenopopulations.

RESULTS AND DISCUSSIONS

Astrantia major L. is a perennial herb 90-110 cm in height and with a short rhizome. Stems are upright single, a little branched in the top, with three single-family macropodous basal leaves and smaller stem. The flowers are small, numerous, white and pink, collected in simple umbels (ray flowers are staminate, median – monoclinous). Fruit – dry, oblong-cylindrical cremocarp up to 5 mm with two seeds (3.5*1.3*1.2 mm) obtected on the edges by swollen scales.

According to phenological observations, spring growth of *Astrantia major* L. begins in the CBG in the second decade of April. Initial budding – the third decade of May. It's characterized by annual duration of blossoming from June to August. Mass blossoming lasts about one month since the first decade of July to the first decade of August. Seeds mature in August - September. Vegetation ends in October, but while warm and protracted fall secondary regrowth may occur. In this case, plants with green leaves are covered with snow and freeze out during the winter. In general, species rhythm of development under culture conditions is proceeding with alternating phenological phases in relatively stable periods of time.

Under natural conditions it prefers fertile and moist soil. Under cultural conditions it grows well on sod-podzolic gley sandy-loam soils. However, during periods of drought it needs watering. Photophilous species, which is inured to slight shading. It winters – without shelter. Under cultural conditions, it annually gives self-seeding indicating created conditions of comfort for plants. It spreads both via seed and vegetatively.

Observations showed that *Astrantia major* L. under cultural conditions can spread quite successfully both via seed and vegetatively. Division of mature plants is the fastest way to produce planting material that reaches the reproductive phase of development during the first year of life. It requires that each of the divided rhizome has two or three reproduction buds and own roots. If there are limited number of mother plantations a rhizome may have one bud, but in this case, to obtain well-developed plants the completion of its growing on fertile soils during one year is needed. The optimal terms for dividing bushes are early spring (before the total leaf expansion) and autumn (September). Disadvantage of this method is the need for a sufficiently large number of mother plantations that holds the mass reproduction of the species back.

Seed reproduction allows obtaining greater amount of planting material than dividing mother plants. However, in this case plants come into the reproductive phase only in the third year of life.

While seed reproduction the ability of species *ex situ* conditions to form viable seed matters. Comparative analysis showed that the mass of 1,000 seeds of *Astrantia major* L. has varied slightly for years and amounted to 2.3-2.8 g.

Observations showed that under controlled conditions at temperatures of 10ºC and 24ºC *Astrantia major* L. seeds don't germinate.

In the set of experiments, we found that the success of seed reproduction of species studied depends to a great extent on the term of seed sowing and presowing preparation (Table 1).

Table 1

Influence of sowing terms and stratification on seed germination of *Astrantia major* L.

Terms of seed sowing							
summer (fresh-gathered)		autumn (dry)		spring			
				dry		after 2-month stratification	
Duration of seed germination, days	Germination, %	Duration of seed germination, days	Germination, %	Duration of seed germination, days	Germination, %	Duration of seed germination, days	Germination, %
270	*20,3±0,8*	*195*	*52,7±2,2*	*25*	*2,3±0,3*	*17*	*40,0±1,5*

The best time for dry seed sowing in the open ground is the autumn period (late autumn) when low temperatures are sustainable, which results in germination about 53% in May of the next year. Spring sowing (in April) is effective only with the use of seeds that have passed two-month stratification in moist sand at temperatures of 0 − +5ºC. The positive reaction of seeds to low temperatures of the winter period is confirmed by appearance of abundant self-seeding of collection planting in the spring.

Research showed that seed sowing in early spring in heated greenhouses and further growing of seedlings with closed root system provide the opportunity to receive the planting material not only with high decorative qualities, but also within the shortest time limits.

To reach such results the seeds were sown in the first decade of March. A mixture of leaf mould and terrestrial peat (1:1) was used as a substrate. Before seed sowing the substrate was watered well with 0.2 % solution of potassium permanganate. In experiments the seeds that passed two-month stratification were only used. They were evenly dispersed over the ground, mulched with a layer of substrate (3−4 mm) and covered with glass. During seed germination daytime temperature was maintained at the level around 25°C, at night – no less than 15-16°C, and humidity that let exclude overdrying

and overwatering of the substrate was provided. Seedlings were regularly aired. The young shoots appeared under greenhouse conditions in 18 days after sowing.

Pricking out the seedlings was carried out in phase of two leaves in plastic cassettes with round cells (a diameter in the upper part accounted for 4 cm, in the lower part – 3 cm, depth – 5 cm) and containers with volume of 0.3 liter. A few hours before pricking out, the seedlings were watered well. After shortening the roots by one third the plants were carefully lowered into the prepared substrate wells almost to cotyledon leaves, gently crimped and watered. The seedlings that were left in boxes without pricking out in close planting were used as a control.

In May all experimental plants were transferred to the open ground. During the summer period the plants were provided with agrotechnical tending, and were fed with a universal fertilizer «Kemira» at an interval of two weeks.

The assessment of biometric indicators held in September showed that in the process of growing of the seedlings *Astrantia major* L. with the closed root system growing space plays an important role in plant development (Table 2).

Table 2

Development of above-ground organs and seedling phytomass formation of *Astrantia major* L. while growing with open and closed root system

Growing method	Plant height cm	Quantity, pcs.		Phytomass, g/plant		
		shoots (buds)	leaves	above-ground part	roots	total
control	*14,3±0,7*	*1,0±0*	*3,7±0,3*	*1,1±0,1*	*0,4±0*	*1,5±0,1*
in containers 0,3 l	*12,3±0,9*	*2,3±0,3*	*10,3 ±1,3*	*3,0±0,1*	*3,2±0,2*	*6,2±0,2*
*in cassettes 4*3*5(cm)*	*2,3±0,3*	*1,0±0*	*4,7±0,3*	*0,4±0*	*0,2±0*	*0,6±0*

So plants grown in 0,3 l containers have a number of shoots 2.3 times greater than in cellular cassettes and control variants, the quantity of leaves – 2.3 and 2.8 times, respectively. Total seedling phytomass in containers exceeded phytomass in close planting by 4.1 times, and in cassettes – 10.3 times.

Advantages of 0,3 l container compared to other options while growing of *Astrantia major* L. are clearly shown on the figure.

Along with the research on biological features at the collection areal observations were made

Development of plants depending on growing conditions:

1 – control; 2 – 0,3 l containers; 3 – cassettes

among artificial cenopopulations. They were created in spring 2013 in the sector of the Belarusian flora by planting adult generative shoots in accordance with the requirements of *Astrantia major* L. to light, degree of moisture, fertility, structure and soil acidity. Square-cluster method of planting (50 x 50 cm) allowing large-sized plants was used to ensure sufficient growing space in the future. Planting was held in the wells due to the size of the root system and minimal disturbance of the soil cover. Using such method of cenopopulations creating 100% survival rate of plants was noted, 70% of which came into the reproductive phase in the year of planting.

Research showed that by providing conditions most closely resembling to the plants biological requirements *Astrantia major* L. can grow without rejuvenation up to 10 years. Besides, it keeps up high decorative qualities and resistant to diseases and pests.

CONCLUSIONS

Undertaken research showed, that complete cycle of seasonal development under *ex situ* conditions, annual bearing, opportunity of seed and vegetative reproduction, presence of significant self-seeding, resistance to unfavorable environment, diseases and pests determine the potential growth opportunities of *Astrantia major* L. as planting material and successful repatriation of the species in natural habitats.

BIBLIOGRAPHY

1. L.I. Khoruzhik (chairman), L.M. Sushchenya, V.I. Parfenov and others, Red Data Book of the Republic of Belarus: Rare and endangered species of wild plants, “Belaruskaya Entsyklapedyya”, Minsk, 2005, 1-456 p.

2. Parfenov V. I., Semerenko L. V., Dubovik D. V. And others Botany (research) The role of particularly protected natural areas in the Republic of Belarus in preservation of species diversity of vascular plants, «Law and Economics», Minsk, 2011, Issue 40, P. 97-126.

3. Yurkevich. I.D., Golod D.S., Yaroshevich E.P., Phenological research of woody and herbaceous plants, “Science and Technology”, Minsk, 1980, 1-88 p.

4. Torchyk S.P., Titok V.V., Peculiarities of development and seed reproduction of some rare and endangered natural flora plants of Belarus in cultivated conditions, «Vestsi Natsiyanalnai Akademii Navuk Belarusi» (Proceedings of the National Academy of Sciences of Belarus) Series of biological sciences, 2013, Issue 3, P.23-27.

5. Vladimir Ivlev. Introduction of rare and endangered plants in Central Kazakhstan (experience, assessment, analysis), «LAP LAMBERT Academic Publishing», 2012, 1 – 120 p.

6. Baranova O.G., Dedukhina O.N., Yagovkina O.N. Research on rare plants under reintroduction conditions (Study guide), Izhevsk, 2008, 1-53 p.

PECULIARITIES OF GARDEN-VARIETY FORMS OF CONIFERS INTRODUCTION IN THE REPUBLIC OF BELARUS

V. I. Torchyk

Central Botanical Garden of National Academy of Sciences of Belarus

Abstract. The article presents the results of the comprehensive assessment of 125 taxa of garden-variety forms of conifers. It is recommended for expanding the range of ornamental plants for landscaping garden-variety forms to introduce coniferous species, which are the most stable under conditions of Belarus that provides a reduction of initial assessment of deserving cultivars by 5-6 years.

Key words: garden, conifers, introduction.

INTRODUCTION

First attempts of garden-variety forms of conifers introduction were made in the beginning of XIX century on the territory of Belarus. During that period parks were actively founded, so that stipulated a need for new and original trees and bushes. For several centuries park construction has stimulated and determined the peculiarities of plants introduction, including their garden-variety forms. However, at that time their taxonomic structure was relatively small. The focus was on coniferous species which were highly decorative and spectacular in single, group and alleys plantings [1, 2]. Research work on garden-variety forms of conifers species introduction was intensified in the late 90s of the last century [3]. The aim of the research was to find a methodical approach to identify perspective garden-variety forms for green building in Belarus.

MATERIALS AND METHODS

In case of recognition for deserving plants for green building the high priority was given to the introduction and research on garden-variety forms of resistant species under conditions of Belarus, as a group of plants, which differs significantly by shaped diversity and sustains high decorative qualities during the whole year.

Objects of research were more than 125 garden-variety forms relating to 35 species of 10 genera of 3 families. Botanical names were taken from [4, 5, 6]. During

the research, the main species of plants which grow in the Central Botanical Garden of NAS of Belarus were determined as a control on the seasonal rhythm of garden-variety forms. The introduction success was determined by the comprehensive assessment results, including seasonal plants development, shoot growth, degree of resistance to environmental factors, diseases and pests.

RESULTS AND DISCUSSIONS

The vast majority of garden-variety forms are characterized by typical individual rhythm of seasonal development. Their vegetation period usually begins earlier or later than that of the original plant species. Garden-variety forms of one species, but with different geographical origin, have differences in start and dates of similar phenological stage from 5 to 20 days or more.

Duration of shoot growth of garden-variety forms is determined by the origin of the original species and peculiarities of the hydrothermal regime of the vegetation period. Garden forms of spruce, pine and yew genera are characterized by a short period of shoot growth with the peak in June-July. The representatives of the Cupressaceous family usually have shoot growth which ends in late August – early September, but due to warm and prolonged autumn it may continue until the end of September and even October. Some species are characterized by secondary shoot growth. It is primarily related to the garden-variety forms of *Picea glauca* (Moench) Voss group *'Conica'*. For the majority of them it lasts for two months and significantly exceeds the duration of the primary shoot growth.

In general, the seasonal rhythms of introducents studied correspond to an annual rhythm of climatic conditions in Belarus that in large extent provided the success of its culture in the region.

Observations of garden-variety forms generative development showed that garden-variety forms of *Taxus baccata* L, *Pinus mugo* Turra., *Thuja occidentalis* L., *Chamaecyparis pisifera* S.&Z., *Chamaecyparis nootkatensis (D.Don) Spach* and some garden-variety forms of genus *Juniperus* L. are characterized by regular seeding.

Seed ripening usually occurs in the second year, some forms – by the end of September. The majority of forms have empty seeds. Embryo of fullness seeds forms by the end of July. Cypress cones of some garden forms (Juniperus virginiana f. *'Burkii'*, Juniperus communis f. *'Bruns'*) are preserved until the following spring, that increases their decorativeness.

Garden-variety forms differ from the main plant species to a small extent by a degree of winter resistance. The most common types of winter damage (5–10%) are

freezing of annual shoot growth and needles partial dieback. Those damages were observed almost every year over the garden-variety forms of *Juniperus chinensis* L. and *Taxus baccata* L. During unfavourable winters, the root system of garden-variety forms of *Taxus baccata* L. can be damaged when grown in containers due to long-term roots growth and lack of its lignification.

In Belarus, garden-variety forms of conifers are quite resistant to diseases and pests. There was a damage caused by diseases of needles and branches only in certain years with a prolonged cold and wet spring with a prior snowy winter with thaws. *Botryris cinerea* Pers is the major disease-producing factor for garden-variety forms of *Thuja occidentalis* L., *Chamaecyparis pisifera* S.&Z. and other conifers. The disease is characterized by the formation of thick mycelium enveloping the needles and branches especially inside the bush. At the high degree of the disease development, dieback of lower branches was noted on which sclerotia were formed under wet weather conditions. The last-mentioned being preserved in soil and on plants spring germinated into mycelium. The disease often had a focal character. In some cases, fungus *Alternaria* spp. caused damage of conifer of garden-variety forms of *Thuja occidentalis* L. in thick planting. Fungus *Phytophtora cactorum* Schroet caused bark damage of garden-variety forms of *Taxus baccata* L. Foveate spots formed at the lower part of stem, root collar, which at the high degree of development caused a gradual wilting and dying of the whole plant. Increased air humidity and thick planting facilitated the development of the disease. *Phacidium infestans* Karst caused damage of conifer of garden-variety forms of *Pinus mugo* Turra., *Pinus nigra* Arnold. and *Picea pungens* Engelm. The highest degree of the fungus development was also noted on the plants which have been under snow for a long time or grown under wet humidity conditions.

Poecilophyllous forms are relatively pest resistant in the Belarus climate. Examples include *Juniperus x media* 'Blue and Gold', 'Plumosa Albovariegata' and 'Plumosa Aureovariegata', as well as *Juniperus chinensis* 'Variegated Kaizuca', *Juniperus squmata* 'Golden Flame', Chamaecyparis pisifera 'Snow'. They have "coloured" shoots damaged in winter and spring which are susceptible to increasing sun influence in the middle of February until snow melt. However, in spite of temporary decrease in ornamental value, most of the investigated poecilophyllous forms can be used successfully for landscaping in Belarus [7].

According to results of the comprehensive assessment, 122 cultivars were recommended for green building in the republic, 26 of which require compliance with specific agricultural techniques of growing and care. Taking into account the generalized experience of the introduction during the past years, more than 200 cultivars can be successfully used for gardening (table).

Taxonomic structure of garden-variety forms of conifers recommended for green building in the Republic of Belarus

Species	Cultivated variety
1	2
Abies alba Mill.	*'Pyramidalis'*
Abies concolor Lindl. et Gord.	*'Violacea'*
Larix decidua Mill.	*'Kornik', 'Pulii'*
Larix kaempferi (Lambert) Carr	*'Blue Dwarf'*
Picea abies (L.) Karst.	*'Barryi', 'Echiniformis', 'Cupressina', 'Inversa', 'Little Gem', 'Nidiformis', 'Parviformis', 'Pendula', 'Procumbens', 'Pumila Nigra', ' Remontii', 'Repens', 'Virgata', 'Will's Zwerg'*
Picea abovata Ledeb.	*'Krilovii'*
Picea glauca (Moench) Voss	*'Alberta Blue', 'Alberta Globe', 'Arnesons Blue Variegat', 'Conica', 'Daisy's White', 'Laurin', 'Echiniformis', 'Piccolo', 'Sanders Blue'*
Picea mariana (Mill.) B.S.P.	*'Beissneri', 'Nana'*
Picea omorica (Pančic) Purkyně	*'Nana', 'Pendula'*
Picea orientalis (L.)Link.	*'Aurea'*
Picea pungens Engelm.	*' Glauca', 'Glauca Globosa', 'Hoopsii', 'Montgomery'*
Pinus cembra L.	*'Columnaris'*
Pinus mugo Turra.	*'Gnom', 'Hesse', 'Humpy', 'Mops', 'Winter Gold'*
Pinus nigra Arnold.	*'Pyramidata'*
Pinus sylvestris L.	*'Aurea', 'Fastigiata'*
Pinus strobus L.	*'Radiata'*
Tsuga canadensis (L.) Carr.	*'Cole Prostrata', 'Compacta', 'Minima', 'Nana'*
Taxus baccata L.	*'Adpressa', 'Amersfort', 'Aurea Decora', 'Aurea Variegata', 'Dovastoniana', 'Elegantissima', 'Fastigiata Variegata', 'Kornik', 'Repandens Aurea', 'Sommergold'.*
Taxus x media Rehd.	*' Hicksii', 'Hillii'*
Chamaecyparis nootkatensis (D.Don) *Spach*	*'Aurea', 'Glauca', 'Tatra', 'Viridis'*
Chamaecyparis obtusa (S.& Z.)	*'Lycopodioides'*
Chamaecyparis pisifera (S.& Z.)	*'Boulevard', 'Filifera', 'Filifera Nana', 'Filifera aurea nana', 'Nana', 'Nana Aureavariegata', 'Plumosa', 'Plumosa aurea', 'Plumosa flavescens'*
Juniperus chinensis L.	*'Aurea', 'Blaauw', 'Blue Alps', 'Blue Point', 'Columnaris', 'Jowa', 'Kaizuka Variegata', 'Keteleeri', 'Kuriwao Gold', 'Mountbatten', 'Obelisk', 'Old Gold', 'Plumosa Aurea', 'Plumosa Albovariegata', 'Plumosa Aureovariegata'*

Table Continuation

Juniperus communis L.	*'Anna Maria', 'Arnold', 'Bruns', 'Gold Cone', 'Green Carpet', 'Depressa', 'Depressa aurea', 'Hibernica', 'Hornibrookii', 'Horstmann', var. 'Jaakii', 'Minima', var. 'Montana', 'Repanda', 'Sentinel', 'Suecica'*
Juniperus davurica Pall.	*'Expansa', 'Expansa Variegata'*
Juniperus horizontalis Moench	*'Agnieszka', 'Blue Chip', 'Cupressifolia', 'Douglasii', 'Erecta', 'Glauca', 'Grey Pearl', 'Hughes', 'Plumosa', 'Reptans'*
Juniperus x media van Melle	*'Blue and Gold', 'Gold Star', 'Golden Saucer', 'Hetzii', 'Mint Julep', 'Pfitzeriana', 'Pfitzeriana Aurea', 'Pfitzeriana Compacta', 'Pfitzeriana Glauca'*
Juniperus procumbens (Endl.) Miq	*'Bonin Jsles'*
Juniperus sabina L.	*'Arcadia', 'Broadmoor', 'Buffalo', 'Tamarscifolia', 'Aurea-variegata', 'Cupressifolia', 'Erecta', 'Rockery Gem'*
Juniperus scopulorum Sarg.	*'Blue Arrow', 'Pathfinder'*
Juniperus squamata D.Don.	*'Blue Carpet' ,'Blue Star', 'Golden Flame', 'Holger', 'Meyeri', 'Prostata'*
Juniperus virginiana L.	*'Burkii', 'Canaertii', 'Glauca', 'Grey Owl', Skyrocket', 'Tripartita'*
Thuja occidentalis L.	*'Albo spicata', 'Aureo-spicata', 'Aurescens', 'Bodmeri', 'Boothii', 'Columna', 'Compacta', 'Danica', 'Douglasii pyramidalis', 'Dumosa', 'Ellegantissima', 'Ellwangeriana aurea', 'Ericoides', 'Fastigiata', 'Filiformis', 'Europe Gold', 'Globosa', 'Globosa nana', 'Golden Globe', 'Gold Perle', 'Goveya', ' Malonyana', 'Holmstrup', 'Hoseri', 'Little Champion', 'Ohlendorfii', 'Pendula', 'Pyramidalis', 'Recurva nana', 'Reingold', 'Robusta', 'Smaragd', 'Spiralis', 'Stolvijk', 'Sunkist', 'Teddy', 'Tiny Tim', 'Thuepsoides', 'Umbraculifera', 'Vervaeneana', 'Wagneriana', 'Wareana Lutescens', 'Woodwardii'*
Thuja plicata D.Don.	*'Zebrina'*
Thujopsis dolobrata Zieb. Et Zucc.	*'Variegata'*

CONCLUSIONS

Garden-variety forms of conifers with a pronounced dwarf growth, grown in the selection process, are prospective for landscaping in Belarusian cities.

As a result of comprehensive assessment (seasonal development, shoot growth, attitude to environmental factors, diseases and pests) of 125 taxa, was determined that the resistance of garden-variety forms plants is largely correlated with the degree of adaptation to local conditions of parent species.

A new methodological approach to identify perspective plants, based on consideration of genotypic characteristics of growth and development of garden-variety forms of species, which are the most stable in the case of Belarus to reduce their initial assessment for 5-6 years, is suggested.

BIBLIOGRAPHY

1. Shkutko, N.V. *Conifers of Belarus.* «Nauka i tekhnika», Minsk, 1991. – 263 p.

2. Fedoruk, A.T. *Belarusian landscape art*. «Uradzhay», Minsk, 1989. – 247 p.

3. Torchyk U.I., Antonyuk E.D. *Ornamental garden-variety forms of conifers.* «Edit VV», Minsk, 2007. – 152 p.

4. Krüssmann, G. *Handbuch der Nadelgehölze*. «P. Parey», Berlin und Hamburg, 1983. – 395 s.

5. Bärtels, A. *Enzyklopedie der Gartengehölze*. «Ulmer», Stutgart, 2001. – 800 s.

6. Hoffman, M.H.A. *List of names of woody plants: International standard ENA 2005–2010.* «Applied Plant Research», Boskoop, 2005. – 871 p.

7. Torchik, **V**. Evaluation of an Assortment of Ornamental Forms of Conifers in Central Botanical Garden of Belarus National Academy of Sciences, Acta Horticulturae, 2010, № 885, P. 375 –381.

IV. LANDSCAPE ARCHITECTURE

SUGGESTIONS IN REHABILITATION OF LANDLORD PARK IVANCEA

Cristina Ciobanu
Institute of Ecology and Geography of Academy of Science of Moldova

Abstract. This article is a work about the Park Ivancea from district Orhei, Republic of Moldova. The park was set up in 1880 by K. A. Balioz, a noble with Armenian origins. The park has a surface of 3, 5 ha, it is valuable for its rich collection of exotic plants, history and cultural significance. We presented some suggestions for park's rehabilitation regarding alleys, plants, fountains and other details.
Key words: rehabilitation, garden, landford park Ivancea.

INTRODUCTION

The old landlord parks are a special type of green areas where the beauty of the nature is combined with human creation, making various landscapes. On the current territory of the republic were created around 55 parks [1]. One of these old parks is Ivancea from village Ivancea, Orhei. It was set up in 1880, the park has a surface of 3, 5 ha. It has a valuable collection of exotic plants: The most exotic coniferous species are thuja *(Thuja occidentalis),* Caucasian spruce *(Picea orientalis),* white fir *(Abies alba),* soft pine *(Pinus strobus)*; hardwood: large-leaved lime *(Tilia platyphyllos F. laciniata),* mountain elm *(Ulmus Scraba* Mill.*)*; shrubs: wisteria *(Wisteria sinensis* Sw.*)*, small leaved sprirae *(Spiraea micropetala* Zab.*)* and others. During its existence, park supported different changes, it needs rehabilitation.

MATERIALS AND METHODS

The object of this study was the old landlord park (historic garden) Ivancea from district Orhei. Important information was obtained via cartographical, historical method, during field trips, studying old plans [1, 2, 3] and international strategies about rehabilitation of historic gardens [4].

RESULTS AND DISCUSSIONS

Ivancea Park was created in the concept of "villa rustica", which means that it has an orchard and a decorative part as it can be seen in the scheme of the park [fig. 1]. In the orchard were planted different kind of trees: apples, plums, cherries and others. Nowadays many trees are old, dry or got wild. From this point of view, we propose planting of new fruit trees. All tree saplings should be of local species.

Talking about the decorative part of the park, we would like to start with improvement of fountains. Some specialists [2, 5] wrote in their studies that in the past were more fountains, but they were lost. Nowadays, on the park's territory are 2 fountains, in the sector B and the sector E (fig. 2), both don't work. They need to be put in function and cleaned of leaves and garbage.

Also, a lot of garbage, which remains especially from the reconstruction of the building, was found in the sector D of the park (fig. 3). Causes of this are the big distance from mansion and proximity to household buildings. Being far away from the manor, they (sector C and D of the park) had been given less attention, hence their poor condition.

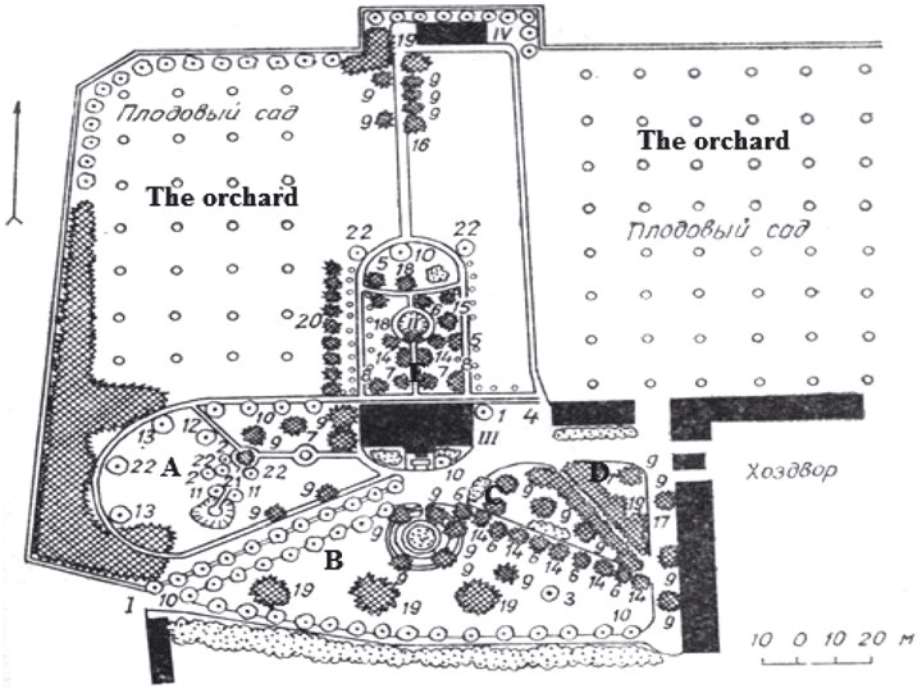


Fig. 1. Plan of Park Ivancea [3]
I – Entrance; II-IV – Buildings; 1-22 – species of plants; A-E park's sectors

During our field trips we observed that some trees are wilted, especially coniferous trees. Broadleaved trees are in a better condition; however, some of them need to be cleaned of brushwood and to be given a shape. Some conifers died in summer of 2012 [5], especially silver fir *(Abies alba* Mill.*)*. We suggest doing an inventory of all wilted trees and replacing them with young saplings.

All park's territory needs to be cleaned of garbage. As it was mentioned before, in some places are left materials and tools. These objects ruin the beautiful landscape of the park.

And firstly, it is necessary to clear the juridical state of the park as now it is the object of the process between its owner and renter (Museum of Ethnography and Natural History and company "Casa Vinului"), the company rented the estate in 2006 [6, 7]. In 2007, company "Casa Vinului" has started the restoration project of the buildings from the estate without elaborating documentations according to law. In 2008 the project was stopped. All works performed by "Casa Vinului" on the mansion are in flagrant contradiction with the principles of restoration of objects of cultural heritage; the result was distortion and degradation of the architectural monument. Unfortunately, it takes a lot of time, as the process has started in 2006 [8].

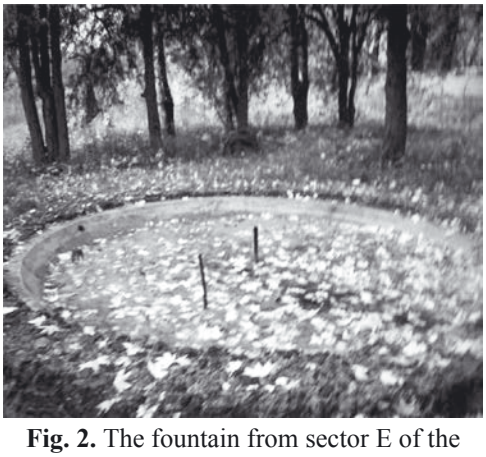


Fig. 2. The fountain from sector E of the park

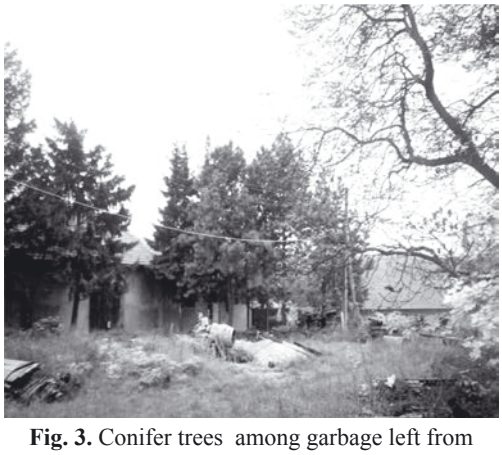


Fig. 3. Conifer trees among garbage left from reconstruction of buildings (sector D)

CONCLUSIONS

The park from Ivancea is in a well condition as it was seen during our field trip and explained in this paper. The most difficult in its rehabilitation is the juridical issue; we hope that it will be solved soon. Most of the plants have good characteristics, only some conifer trees died a couple of years ago when was a hard winter. Regarding

small architectural forms, fountains need to be cleaned, repaired and put in function. Also, some alleys from the park need a better care. As is shown, this park doesn't need big measures for rehabilitation, with some efforts it will be marvelous like at the beginning.

BIBLIOGRAPHY

1. Дормидонтова В. *Гармония искусства и природы.* Штиинца, Кишинёв, 1992, 142 с.

2. Леонтьев П. *Парки Молдавии.* Картя Молдовеняскэ, Кишинёв, 1967, 95 с.

3. Кравчук, Ю., Верина В., Сухов И. *Заповедники и памятники природы Молдавии.* Кишинев: Штиинца, 1976, 312 с.

4. Babur's Garden Rehabilitation Framework. http://www.akdn.org/publications/2004_afghanistan_babur.pdf (accessed 31.01.2014)

5. Tarhon P. *Parcuri vechi boiereşti din Republica Moldova*. Chişinău: Pontos, 2013. 637 p.

6. Contractul de locuţiune nr.105 din 17.10.2006 între Muzeul Naţional de Etnografie şi Istorie Naturală şi SRL „Casa Vinului". https://www.facebook.com/media/set/?set=a.360481797309913.91010.212165758808185&type=3, (accessed16.04.2014)

7. Contractul de colaborare nr.106 din 17.10.2006 între Muzeul Naţional de Etnografie şi Istorie Naturală şi SRL „Casa Vinului". https://www.facebook.com/media/set/?set=a.360481797309913.91010.212165758808185&type=3, (accessed16.04.2014)

8. Raportul Comisiei de anchetă pentru investigarea cazurilor de demolare şi deteriorare, în perioada anilor 1993–2012, a unor monumente istorice incluse în Registrul monumentelor Republicii Moldova ocrotite de stat. Chişinău, 2013. http://www.slideshare.net/ghenador/1882013ro, (accessed16.04.2014)

V. SCIENTIFIC CHRONIC

DR. HAB. ANA ŞTEFÎRŢĂ, THE 75TH BIRTHDAY

Field of research: *paleobotany, floristics*

Ana Ştefîrţă was born on 30 July 1939 in the village Cotiujenii-Mari, district Soroca. After graduating from the general secondary school in her native village, she continued her studies at the Tiraspol State University, graduating in 1965 from the faculty of biology and chemistry.

In order to apply the obtained knowledge, in 1965, she is employed as an assistant lecturer at the Chair of Botany of the same university. After a brief pedagogical activity, in 1968, Mrs. Ana Ştefîrţă started her doctoral studies at the Botanical Garden of Academy of Sciences of Moldova, and continued them at the Institute of Botany "V.L.Komarov" of the Russian Academy of Sciences in St. Petersburg.

In 1972, she defended her doctoral thesis, the speciality – "03.00.05 – botany", on the theme: "*Миоценовая флора с. Бурсук в Молдавии*" *("Miocene flora from v. Bursuc, Moldova")*, in 1990, she is conferred the title of Research Associate Professor in botany and, in 1997, she defended her habilitation thesis on the theme: „*Flora miocenă din interfluviul Nistru-Prut*" (*Miocene flora of the interfluve Nistru-Prut*).

During her research activity, she advanced from junior researcher to senior researcher and head of the Herbarium of the Botanical Garden (Institute) of the ASM.

The scientific activity of Dr.hab. Ana Ştefîrţă was dedicated to studying the history of development of the Miocene fossil flora from the Republic of Moldova.

She discovered and determined 21 species of fossil plants of Miocene flora from

the territory of the interfluve Nistru-Prut. She confirmed the existence in the Early Sarmatian of "Mastixia" chronoflora.

The high taxonomic diversity, floristico-phytocenotic compositional specific and precisely dated stratigraphic position allowed assigning to the Early Sarmatian phyto-complex "Bursuc" the status of "*Standard Flora*" for the Early Sarmatian of Eastern Paratethys and made possible the expansion of the paleobotanical researches on the Miocene flora of Eastern Europe.

Studying the development of Late Miocene flora on the Nistru-Prut territory, she found that there were two successive stages: *Early-Sarmatian* and *Sarmatian-Pontian*.

The results of scientific researches have been published in about 70 works, including: the monograph „*Раннесарматская флора Бурсука*" (1974) and she is co-author of nine monographs («*Ископаемые цветковые растения СССР*», том. 1, 2 (1974; 1982); «*Ископаемые цветковые растения России и сопредельных территории*», том. 4. (1994); «*Растительный мир Молдваии*», том. 1, (1986); „*Lumea vegetală a Moldovei*", vol. 2, 3 (2005, 2006); „*Flora Basarabiei*" etc.).

Merits:

- the honorary title „Om emerit" of the Republic of Moldova, 2001;
- Diploma of gratitude of the Academy of Sciences of Moldova, 2009.

DECISION
International Scientific Symposium
"*Conservation of plant diversity*",
Third edition 22-24 may 2014, Chisinau, Republic of Moldova

The problem of biological diversity is one of the main concerns of humankind, and its conservation is a prerequisite for the sustainable development of socio-economic systems. The extinction of numerous species of plants and animals was based on human actions more or less rational.

Nowadays, the problem of biodiversity conservation goes beyond the limits of scientific directions and is a stringent objective, a priority of states and international institutions.

In order to achieve performances in this field, it is necessary to continue the research processes in the field, the monitoring, to intensify the activities on environmental education and training, to increase public awareness, conservation and rational use of natural resources, to increase energy efficiency and to reduce the impact of climate change. The uncertainties related to the depletion of natural resources and the increasing demands of humankind can be overcome only through the development of new concepts and modern technologies.

The International Scientific Symposium "*Conservation of plant diversity*", the third edition, 22-24 May 2014, Chisinau, Republic of Moldova, organized by the Botanical Garden (Institute) of Academy of Sciences of Moldova in collaboration with the University of ASM fits well the range of actions promoted on the basis of the Convention on Biological Diversity Programmes that are meant to stop definitively the extinction of species on Earth, to restore biotopes, biocenoses and taxa specific to the populations destroyed or extinct on their native lands.

The value and the level of the Symposium are determined by the participating institutions from:

REPUBLIC OF MOLDOVA: Botanical Garden (Institute), ASM; University of ASM; Moldova State University; State University of Medicine and Pharmacy "Nicolae Testemitanu", Institute of Genetics, Physiology and Plant Protection, ASM; Institute of Ecology and Geography, ASM; Institute of Microbiology and Biotechnology, ASM; Centre of Molecular Biology, UnASM; Research Institute of Horticulture and Food Technology, MAFI; Research Center "AMG-Agroselect"; Institute of Biotechnology in Animal Husbandry an Veterinary Medicine, MAFI; Forest Research and Management Institute; Scientific Reserves "Codriii" and "Pădurea Domnească", Moldsilva;

ROMANIA: University of Bucharest; Botanical Garden „A.Fătu" of the University "Al.I.Cuza", Iaşi; Botanical Garden "D. Brandza", Bucharest; Institute of Biological Research, Iaşi; "Stejarul"Biological Research Centre, Piatra Neamţ; Agricultural Research and Development Station "Secueni";

UKRAINE: National Botanical Garden "N.N. Grisko", Kiev; Nikitsky Botanical Garden (Crimea); A.V. Fomin Botanical garden of T. Shevchenko National University, Kiev; Bila Tserkva National Agrarian University; Botanical Garden of Odessa I.I. Mechnikov National University);

RUSSIA (N.V. Tsitsin Main Botanical Garden, RAS; Russian Selection and Technological Institute of Horticulture and Nursery; Ufa Botanical Garden);

BELARUS: (Central Botanical Garden of NAS);

AZERBAIJAN (Institute of Genetics Resources, ANAS; Mardakan Arboretum, ANAS), which represent scientific and cultural centres of both national and international importance, regarding *in situ* and *ex situ* conservation, acclimatization and regeneration in the optimal artificial conditions of native and alien plant species valuable scientifically, economically and aesthetically, establishment of banks of seeds and tissues. These collections serve as a repository of plant gene pool and genetic resources of reproductive material and are intended to be preserved for the present and future generations.

The scientific reports presented at the Symposium by the participants mirrored a higher stage in the development and implementation of research methods in the domain, evaluation of obtained results and implementation of advanced elaborations in the branches of the national economy, promotion of knowledge in society. Furthermore were addressed scientific problems for the future, whose solution will improve the effectiveness of the measures of conservation of biological diversity, mobilization of plant gene pool and sustainable use of plant resources. The reports of the participants included the results of recent investigations, conducted both in our country and abroad, having as a topic the structural botany and biotechnology, the conservation of the plant world, the introduction of plants and sustainable use of plant resources, the planning of urban and rural green spaces, the ecological education of the population, etc.

So, we can conclude that the researches carried out in the science centres, which participated at the Symposium, constitute a significant contribution to biodiversity conservation by theoretical elaborations, promotion of new concepts and hypotheses in the field.

It is significant that the botanical researches in the Republic of Moldova have received a considerable impulse after the promotion of the Science and Innovation Code, the foundation of the Educational Scientific Cluster UnivER SCIENCE, accession of the Republic of Moldova to the European Union 7th Framework Programme, which mobilized the creative potential of scientists, opened opportunities for integration through Horizon 2020 Programme into the international scientific community, created the conditions for training and promoting young researchers, implementation in national economy branches of valuable elaborations, attracting investments to endow with advanced scientific equipment, supporting priority scientific researches.

International Scientific Symposium "*Conservation of plant diversity*", third edition, 22-24 May 2014, Chisinau, Republic of Moldova, DECIDES:

1. Adherence of the Botanical Garden to the international standards regarding the mission, structure, management, organization on compartments, which actually reflects the mission of this institution in the social system.
2. Continuation and development of scientific and technical topics on studying plant diversity and sustainable use of plant resources, introduction and enrichment of existing collections, creation of new collections through international seeds fund exchange, promotion of complex expeditions in common with international profile institutions.
3. Expanding the collaboration with Regional Science Centres from Azerbaijan, Belarus, Romania, Russia, Ukraine, etc. on the promotion of landscape architecture as an active tool in the conservation and wise use of the plant world, environmental education and awareness of population.
4. Involvement of specialists in the development of scientific research projects at national and international level, meant to ensure the flow of information between scientific centres, oriented toward evaluation, conservation of plant diversity and sustainable use of plant resources.
5. Improving the scientific potential according to the European policy concerning the scientific research, conservation and management of plant diversity on the basis of expansion of cooperation with international and regional centres, joint use of the advanced equipment from these centres.
6. Enhancing cooperation with higher education institutions in professional training of young scientific staff through various specializations, master, doctorate, post-doctorate.
7. Raising public awareness on biodiversity conservation and maintenance of ecological balance by organizing various activities, contests, seminars etc.
8. Integration of the aspects regarding plant diversity conservation and sustainable use of plant resources in the economy.
9. Expansion of the system of protected natural areas in order to ensure optimal functioning of natural ecosystems.
10. Taking measures concerning the recovery and restoration of endangered species and their reintroduction into their natural habitats under appropriate conditions.
11. Implementation of advanced scientific elaborations in various branches of the national economy.
12. Development and promotion of a plan for construction and development *(Main Entrance, Fund Exhibition Greenhouse, Botanical Museum, Network of Ornamental Paths and Bridges)* of Botanical Garden (Institute) of Academy of Sciences of Moldova.

The participants at the International Scientific Symposium "*Conservation of plant diversity*", the third edition, 22-24 May 2014, Chisinau, Republic of Moldova.